SAVING ENERGY
LEARNING & CONSERVING
Student Guide

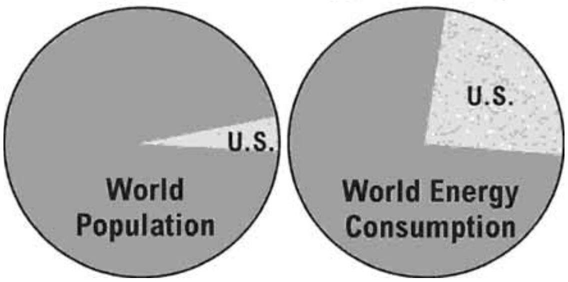
NEED
2009-2010
Putting Energy into Education

NEED Project PO Box 10101 Manassas, VA 20108 1-800-875-5029 www.NEED.org

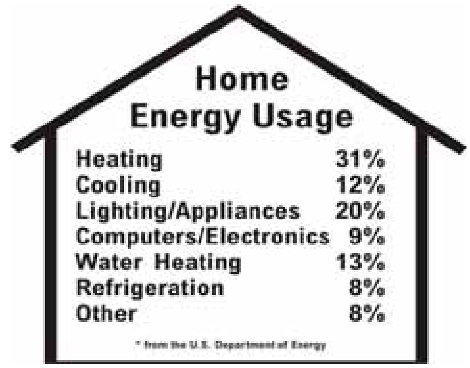
INTRODUCTION

The United States uses a lot of energy—nearly a million dollars worth of energy each minute, 24 hours a day, every day of the year. With less than five percent of the world's population, we consume about one-fifth (21 percent) of the world's energy resources. We are not alone among industrialized nations; 16 percent of the world's population consumes 80 percent of its natural resources.

U.S. Population & Energy Consumption



The average American consumes six times the world average per capita consumption of energy. Every time we fill up our vehicles or open our utility bills, we are reminded of the economic impacts of energy.



ENERGY EFFICIENCY & CONSERVATION

Energy is more than numbers on a utility bill; it is the foundation of everything we do. All of us use energy every day—for transportation, cooking, heating and cooling rooms, manufacturing, lighting, water-use, and entertainment. We rely on energy to make our lives comfortable, productive and enjoyable. Sustaining this quality of life requires that we use our energy resources wisely. The careful management of resources includes reducing total energy use and using energy more efficiently.

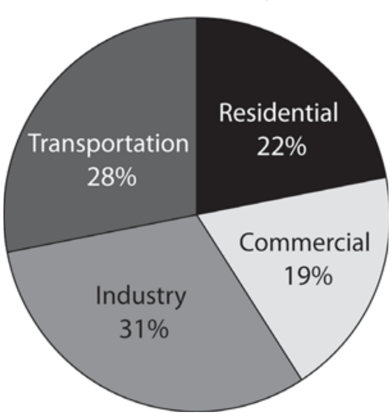
The choices we make about how we use energy—turning machines off when not in use or choosing to buy energy efficient appliances—will have increasing impacts on the quality of our environment and lives. There are many things we can do to use less energy and use it more wisely. These things involve energy conservation and energy efficiency. Many people use these terms interchangeably; however, they have different meanings.

Energy conservation includes any behavior that results in the use of less energy. Energy efficiency involves the use of technology that requires less energy to perform the same function. A compact fluorescent light bulb that uses less energy to produce the same amount of light as an incandescent light bulb is an example of energy efficiency. The decision to replace an incandescent light bulb with a compact fluorescent is an example of energy conservation.

ENERGY SUSTAINABILITY

Efficiency and conservation are key components of **energy sustainability**—the concept that every generation should meet its energy needs without compromising the needs of future generations. Sustainability focuses on long-term actions that make sure there is enough energy to meet today's needs as well as tomorrow's. Sustainability also includes the development of new technologies for using fossil fuels, promoting the use of renewable energy sources, and encouraging policies that protect the environment.

Energy Use By Sector Of the Economy



SECTORS OF THE ECONOMY

The U.S. Department of Energy uses three categories to classify energy users—residential and commercial, industrial, and transportation. These categories are called the sectors of the economy.

Residences are people's homes. Commercial buildings include office buildings, hospitals, stores, restaurants, and schools. Residential and commercial energy use are lumped together because homes and businesses use energy in the same ways—for heating, air conditioning, water heating, lighting, and operating appliances.

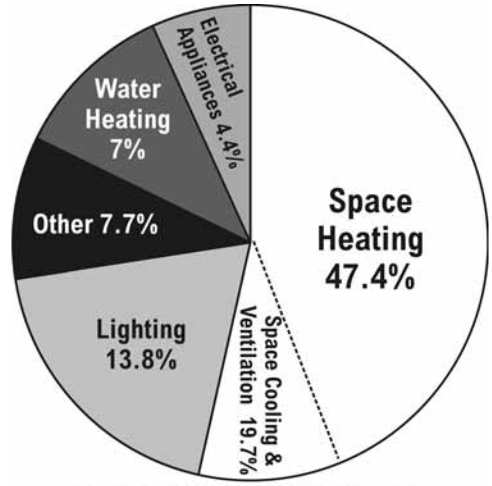
The residential/commercial sector of the economy consumed 40.5 percent of the total energy supply in 2008, more energy than either of the other sectors, with a total of 40.1 quads of energy. The residential sector consumed 21.6 quads and the commercial sector consumed 18.5 quads. Schools are included in the commercial sector of the economy.

SCHOOL ENERGY CONSUMPTION

A school building is an energy system made of many interrelated components. Some of these components are obvious, such as walls, roofs, lights, doors and windows. Occupants—students, teachers, and other building users—are also an important part of the system. The energy use of the system affects everything from the school budget to the global environment. It is important to understand how all of the system components can work together to create an environment in which everyone is comfortable and healthy.

A school building's energy system includes these components:

- **Building Shell:** This component includes everything that creates the boundaries between indoors and outdoors: walls, floors, roofs, windows, and doors.
- **Heating, Ventilation, and Air Conditioning (HVAC) Systems:** This component includes the equipment designed to provide heating, cooling, hot water, and fresh air. It also includes the devices that control the HVAC equipment, such as thermostats.
- **Lighting:** This component usually includes several types of fixtures that provide light for all of the activities in the school.
- **Electrical Appliances:** This component includes everything plugged into electrical outlets, such as refrigerators, copiers and computers, as well as appliances that are wired directly into the school's electrical system, such as ovens and refrigeration equipment in the cafeteria.



SCHOOL ENERGY USE

BUILDING SHELL

All parts of the building that create barriers between the inside and outside are components of the building shell. These parts include walls, floors, ceilings, windows, doors, and skylights. These components work together to reduce heat transfer. Any warm air that flows into the building during cooling season and out of the building during heating season wastes energy. The objective of the building shell is to allow as little heat transfer as possible.


Insulation in Wall Framing

One way to reduce heat transfer is with insulation. Roof systems on most schools include insulation. There may also be insulation in the walls of the building, depending on how it is constructed. Insulation is rated using an **R-value** that indicates the resistance of the material to heat transfer. The higher the R-value, the more effective the material is at reducing heat transfer. Insulation wraps the building in a blanket, slowing the transfer of heat through walls and roofs. This type of heat transfer is called conduction, the flow of thermal energy through a substance from a higher to a lower temperature area.

Even with insulation, air can still leak in or out through small cracks. Heat is carried along with the air through these cracks. Often the many small cracks in a building add up to a hole the size of a wide open door. Some of the cracks are obvious—those around doors and windows, for instance. But others are hidden behind walls and above ceilings. Sealing these cracks is a very effective way to stop another type of heat transfer—convection, the transfer of thermal energy through a gas or liquid by the circulation of currents from one area to another.

One of the easiest energy-saving measures to reduce heat transfer is to caulk, seal, and weatherstrip all cracks and openings to the outside, resulting in a 10 percent or more savings in energy costs. Even more savings are possible if a company that specializes in finding and sealing hidden leaks is employed.

Doors should seal tightly and have door sweeps at the bottom to prevent air leaks. It's common to be able to see daylight through cracks around school doors. Most schools have more windows than doors. The best windows shut tightly and are constructed of two or more pieces of glass. Any cracks around the windows should be caulked and the windows checked often to make sure they seal tightly.

When we seal a building by minimizing air transfer, we must keep in mind the need for fresh air for the occupants. To provide fresh air and exhaust stale air, school buildings have mechanical ventilation systems. In buildings with effective ventilation systems, even the windows can be sealed. With a good ventilation system, there should be no concerns with sealing all the air leaks in a school building.

Landscaping: Although the weather can't be controlled, trees can be planted around buildings to block the wind and provide shade. This is an excellent way to make the building shell more energy-efficient. Deciduous trees planted on the south side of a building block the sun in warmer months and allow sun to shine on the building in winter, when the leaves are gone. Conifers planted on the north side of the building can block the north wind. Properly placed trees and bushes can reduce the energy needed to keep a building comfortable.

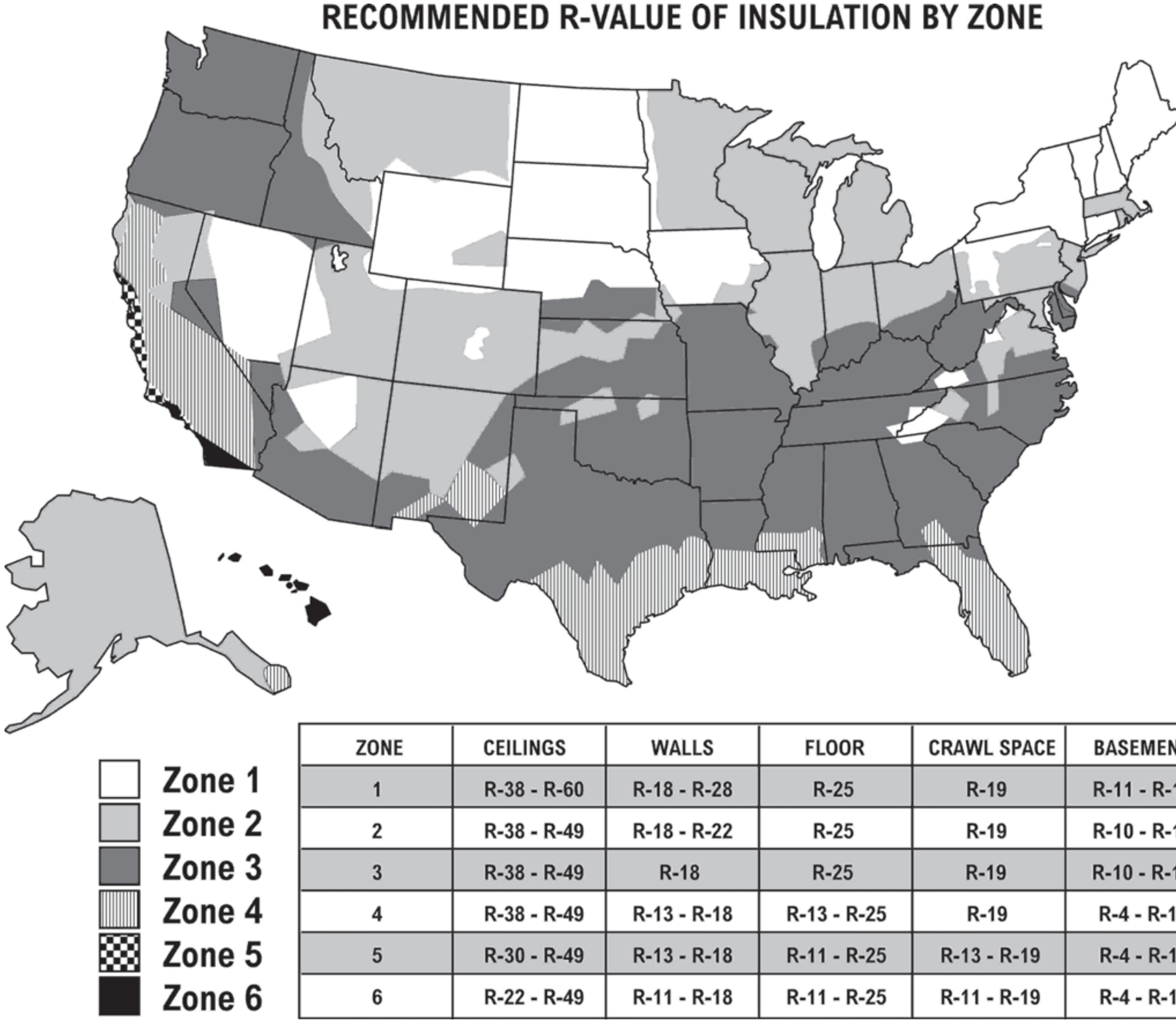
HEATING VENTILATION AND AIR CONDITIONING (HVAC)

Heating and cooling systems, along with ventilation systems, use more energy than any other systems in a school. Natural gas and heating oil, and sometimes electricity, are used to heat most buildings; electricity is used to run cooling systems. Ventilation systems are necessary to provide fresh air and remove stale air and indoor air pollutants. About 67 percent of the average school district's energy bill is used to keep buildings at comfortable temperatures and provide fresh air for the buildings. The energy sources that power these heating and cooling systems (mostly fossil fuels) emit millions of tons of carbon dioxide into the atmosphere each year. They also generate sulfur dioxide and nitrogen oxides that cause acid rain.

Most school buildings are heated by boiler systems. These devices heat water to high temperatures, sometimes converting the water to steam, and then circulate it throughout the building via a system of pipes. Once the water in the pipes has given up its thermal energy to the air in the building, it is circulated back to the boiler to be reheated.

Many classrooms are provided with heat (and some with cooling) by unit ventilators. A unit ventilator is a metal cabinet, usually located underneath a window. Inside the unit are pipes with hot and sometimes cold water. A fan inside blows across the pipes and provides heated or cooled air to the classroom through a vent on the top. A vent at floor level pulls air into the unit from the room. Finally, a vent leads outside to bring fresh air into to the classroom. For a unit ventilator to work efficiently and effectively, the vents at the top and bottom must be kept clear of books and other items.

RECOMMENDED R-VALUE OF INSULATION BY ZONE



ZONE	CEILINGS	WALLS	FLOOR	CRAWL SPACE	BASEMENT
1	R-38 - R-60	R-18 - R-28	R-25	R-19	R-11 - R-19
2	R-38 - R-49	R-18 - R-22	R-25	R-19	R-10 - R-19
3	R-38 - R-49	R-18	R-25	R-19	R-10 - R-11
4	R-38 - R-49	R-13 - R-18	R-13 - R-25	R-19	R-4 - R-11
5	R-30 - R-49	R-13 - R-18	R-11 - R-25	R-13 - R-19	R-4 - R-11
6	R-22 - R-49	R-11 - R-18	R-11 - R-25	R-11 - R-19	R-4 - R-11

Thermostats often control heating and cooling systems in the building. Thermostats can be set for the desired temperature in the rooms. A thermostat is basically an “on-off’ switch. In the heating season, when the temperature in a room falls below the setting, heat is delivered to the room. During cooling season, cool air is delivered when the temperature rises above the thermostat setting.

Many school districts control how high or low the temperatures can be set in different rooms. The most advanced systems use central computers to control heating, cooling, and ventilation. Temperature sensors in the rooms send information back to the computers, which adjust the temperature in the rooms to pre-programmed levels. They automatically control the temperature of buildings for time of day and can save energy and money.

During heating seasons, for example, they can lower the temperature at night and weekends when no one is in the buildings. If requested, the building operator can adjust the program to provide heat and cooling outside of regular building hours for sporting events, community meetings, or concerts.

For HVAC equipment to operate at optimum efficiency, it is necessary to maintain the equipment. Regular maintenance of equipment ensures that all systems and controls are functioning as they should. Every school should have procedures in place that provide for regular maintenance of equipment.

Even if school buildings have energy efficient systems, a lot of energy can be wasted if the energy is not managed wisely. That is where students come in—learning about energy and how to save it.

Temperature Management: The best heating system in the world can’t do a good job if outside doors or windows are left open, or if the temperature isn’t controlled. The same is true for cooling systems. In classrooms and offices, it is recommended that the temperature be set at 68°F during the heating season and 78°F during the cooling season during the day. Windows and doors should be closed when the heating and cooling systems are operating.

Programmable Thermostat

If the temperature of rooms can be individually controlled, districts should have a policy on acceptable temperature settings. Temperature ranges can vary depending on the functions of the rooms. Gymnasiums, for example, don’t need to be heated as much as classrooms. Auditoriums, hallways, storage rooms, and other little used rooms don’t need to be heated and cooled as much, either.

Rooms and areas with windows in direct sunlight can be equipped with blinds that can help control temperature—closed in cooling months and opened in heating months when sunlight is focused on them.

The relative humidity—the amount of moisture in the air—also affects comfort level. The more moisture, the warmer the air feels. The most comfortable relative humidity setting is between 40–60 percent. This range also minimizes the amount of bacteria, viruses, and molds in the air, and is healthy and comfortable for breathing.

With all heating and air-conditioning systems, energy consumption can be minimized by making sure there is adequate insulation, maintaining the equipment, and practicing energy-saving behaviors. Teaching occupants how to dress practically for the season can help them stay comfortable without using too much heat in the winter or air conditioning in the summer.

Water Heating: Water heating is the third largest energy expense in residential buildings; it typically accounts for about 14 percent of a utility bill. Water heating is usually a much smaller percentage of school energy use, but it is significant. Schools often heat water with the boiler that is used to heat the school building. The water is stored in a separate tank that has its own burner, controlled by a thermostat to keep the water at the desired temperature. Sometimes schools have large stand-alone water heaters, much like those used in residences. These are usually fueled by natural gas or electricity.

Heated water is used for showers, hand washing, dishwashing and cleaning. There are five main ways to lower a school’s water heating bills:

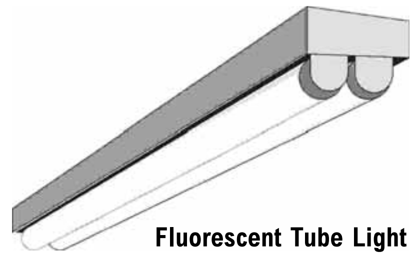
- use less hot water
- make sure there are no water leaks or drips
- turn down the thermostat on the water heater
- insulate water heaters and water pipes
- buy energy-efficient water heaters

The easiest way to cut the cost of heating water is to reduce the amount of hot water consumed. This can be done with little cost and minor changes in lifestyle. Faucet aerators (which diffuse the flow of water from a faucet) can be installed in restrooms and classrooms. They limit the flow of water while providing adequate flow for washing. Many schools also utilize spring-loaded faucets that limit the amount of time the faucet runs. Other ways to conserve hot water include taking shorter showers, fixing leaks in faucets and pipes, and using the lowest temperature water necessary.

Most water heater thermostats are set much higher than necessary. Lowering the temperature setting on a water heater saves energy. Lowering the temperature 10 degrees can result in energy savings of five percent. Installing energy-efficient water heaters in school buildings can save hundreds of dollars a year.

LIGHTING

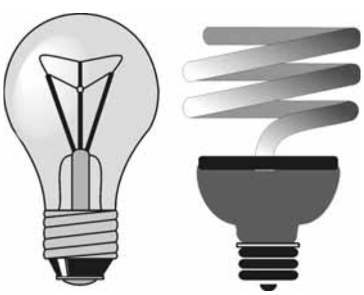
Lighting is a major use of energy in a school. An average school uses 30 percent of the electricity it consumes to light buildings and outside areas. Schools are lit mainly with fluorescent lights.


Fluorescent Tube Light

A fluorescent lamp is a glass tube, whose inner surface has a powdered, phosphor coating. The tube is filled with argon gas and a small amount of mercury vapor. At the ends of the tubes are electrodes that emit electrons when heated by an electric current. When electrons strike the mercury vapor, the mercury atoms emit rays of ultraviolet (UV) light. When these invisible UV rays strike the phosphor coating, the phosphor atoms emit visible light. The conversion of one type of light into another is called fluorescence.

Fluorescent lights have ballasts that help move the electricity through the gas inside the bulb. Ballasts are electromagnets that produce a large voltage between the ends of the bulbs so the electricity will flow between them. There are two types of ballasts, magnetic and electronic. Magnetic ballasts produce a frequency of 60 Hertz (Hz), which means the light is flickering on and off 60 times a second. Electronic ballasts produce a frequency of at least 20,000 Hz. Fluorescent lights with electronic ballasts are more energy-efficient than those with magnetic ballasts.

Electronic ballasts use up to 30 percent less energy than magnetic ballasts. Electronic ballasts operate at a very high frequency that eliminates flickering and noise. Some electronic ballasts even allow you to operate the fluorescent lamp on a dimmer switch, which usually is not recommended with most fluorescents.



Incandescent lighting is also used in schools. Only 10 percent of the energy consumed by an incandescent bulb produces light; the rest is given off as heat. Fluorescent lights produce very little heat and are much more energy-efficient. Compact fluorescents (CFLs) use the same technology as overhead fluorescent lights, but they are designed to fit into lamps and other fixtures where incandescents are commonly used. CFLs can help cut lighting costs 60 to 75 percent and reduce environmental impacts. Although CFLs cost more to buy, they save money in the long run because they use only one-fourth the energy of incandescent bulbs and last 8–12 times longer. Each CFL installed can save $30 to $60 over the life of the bulb. One CFL can reduce carbon dioxide emissions by 260 pounds per year.

Although fluorescent tubes in ceiling fixtures are always more energy efficient than incandescents, there are new, even more efficient lamps that use better electrodes and coatings. They produce about the same amount of light with substantially lower wattage.

Most light fixtures in schools use four-foot long lamps, although 3–foot lamps are common as well. Older fixtures often contain T–12 lamps that are 1-1/2” in diameter and consume 34–40 watts. These lamps can be replaced with energy-saving T–8 lamps that are 1” in diameter and typically consume 28–32 watts. Some newer systems are now using T–5 lamps that are 5/8” in diameter and are even more efficient than the T–8 lamps.

Lighting Controls: Lighting controls are devices that turn lights on and off or dim them. The simplest type is a standard snap switch. Other controls include photocells, timers, occupancy sensors, and dimmers. Snap switches, located in many convenient areas, make it easier for people in large, shared spaces to turn off lights in unused areas.

Photocells turn lights on and off in response to natural light levels. Photocells switch outdoor lights on at dusk and off at dawn, for example. Advanced designs gradually raise and lower fluorescent light levels with changing daylight levels. Mechanical or electronic time clocks automatically turn indoor or outdoor lights on and off for security, safety, and tasks such as janitorial work. An occupancy sensor activates lights when a person is in the area and then turn off the lights after the person has left.

Dimmers reduce the wattage and output of incandescent and fluorescent lamps. Dimmers also significantly increase the service life of incandescent lamps. However, dimming incandescent lamps reduces their light output more than their wattage. This makes incandescent lamps less efficient as they are dimmed. Dimmers for fluorescents require special dimming ballasts, but do not reduce the efficiency of the lamps.

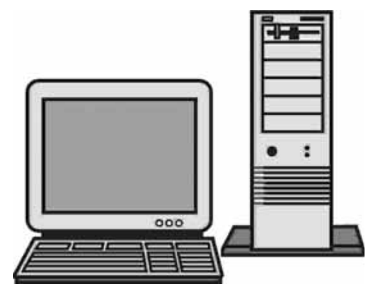
Even the best lighting system isn't efficient if people don't use it wisely. In most schools, more light is used than needed and lights are often left on when no one is present. All lights that are not necessary for safety should be turned off when rooms are not in use. The same is true for outside lights. Using sunlight is a good idea whenever possible. Studies have shown that students learn better in natural light than in artificial light.

ELECTRICAL APPLIANCES

A school building contains many electrical devices (called plug loads) that contribute to the learning process and help occupants stay comfortable and safe. It is estimated that up to 20 percent of the total electricity consumed by a school is used to power these electrical devices. Managing the use of such equipment can greatly reduce a school's electricity consumption.

Look around any classroom and you'll see many appliances. A quick survey of the typical classroom and school building reveals many kinds of electrical appliances, such as:

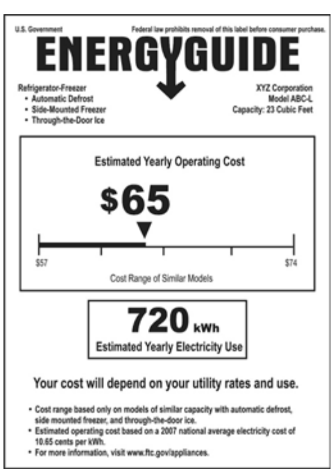
coffee makers	computers/monitors	fans
desk and table lamps	microwaves	refrigerators
televisions	VCRs	window air conditioners
vending machines	printers and scanners	fax machines
copiers	fish tanks	overhead projectors
ranges and stoves	vocational equipment	clocks
drinking fountains	pencil sharpeners	



Many of these devices are important to the learning environment. In addition, there are appliances that teachers and school staff bring from home that are not related to teaching, but are routine devices found in any office. Many electrical appliances such as computers, printers and copiers waste energy when they are left on 24 hours a day. Often they are left on as a matter of convenience because they have a long warm–up time. Turning these machines off at the end of the day, and turning other machines off when they are not being used, can save a lot of energy.

Once students, teachers, and staff are educated about the impacts of energy consumption, they are often willing to reduce their use of these devices. By simply monitoring daily use of plug loads, students and staff can lower the school's utility bills, saving the school system money.

Many computers, TVs, VCRs, and other electrical devices use electricity even when they are turned off. This type of electricity consumption is known as **phantom load**, because it can easily go unnoticed. Phantom loads are also known as **standby power** or **leaking electricity**. Phantom loads exist in many electronic or electrical devices found in schools. Equipment with electronic clocks, timers, or remote controls, portable equipment, and office equipment with wall cubes (small box-shaped plugs that plug into AC outlets to power appliances) all have phantom loads. These devices can consume 3–20 watts when turned off. These appliances should be plugged into surge protectors so that all of the power can be turned off when they are not in use, or at the end of the day.



Federal Government Guidelines for Appliances: When shopping for a new appliance, look for the **ENERGY STAR®** label—your assurance that the product saves energy. ENERGY STAR® appliances have been identified by the U.S. Environmental Protection Agency and Department of Energy as the most energy-efficient products in their classes. If the average American equipped his home only with ENERGY STAR® products, he would cut his energy bills, as well as greenhouse gas emissions, by about 30 percent. A list of these appliances can be found on the ENERGY STAR® website at www.energystar.gov.

CHANGE FOR THE BETTER WITH ENERGY STAR

Another way to determine which appliance is more energy efficient is to compare energy usage using **EnergyGuide** labels. The federal government requires most appliances to display bright yellow and black EnergyGuide labels. Although these labels do not say which appliance is the most efficient, they provide the annual energy consumption and average operating cost of each appliance so you can compare them.

INDOOR AIR QUALITY (IAQ)

Students go to school to learn and, in order to make learning possible, the school building needs to be safe, healthy, and comfortable. One of the most important factors is making sure that the air in school buildings is healthy to breathe. A building with good indoor air quality has students, teachers, and staff who are healthy and alert. To ensure good indoor air quality, schools must eliminate air pollutants and introduce adequate clean, fresh air into the building. The amount of moisture in the building must be regulated, as well.

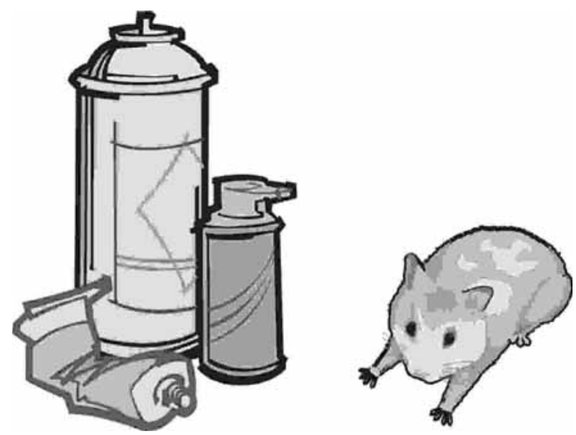
Without efficient ventilation systems, indoor levels of air pollutants can be two to five times higher, and occasionally 100 times higher, than outdoor levels. Nearly 56 million people, approximately 20 percent of the U.S. population, spend their days inside elementary and secondary schools.

In 1999, the National Center for Education Statistics of the U.S. Department of Education reported that approximately 25 percent of public schools described unsatisfactory ventilation, while 20 percent of schools reported unsatisfactory indoor air quality. IAQ problems can cause discomfort and contribute to short and long term health problems for students and staff.

CONTRIBUTORS TO POOR INDOOR AIR QUALITY

Several factors in schools contribute to poor indoor air quality. Some of the most common factors include:

- Excess moisture and mold
- Dry-erase markers and pens
- Dust and chalk
- Cleaning materials
- Personal care products
- Odors and volatile organic compounds from paint, caulk, and adhesives
- Insects and other pests
- Odors from trash
- Students and staff with communicable diseases
- Radon
- Classroom pets



All types of schools—new or old, big or small, elementary or secondary— can experience indoor air quality problems. Schools across the country have an array of indoor air problems. Biological problems, such as mold and mildew, are particularly pronounced in the Southeast where humidity levels are high. Schools across the country, however, even in desert areas, have experienced mold problems.

EFFECTS OF POOR INDOOR AIR QUALITY

Poor indoor air quality can significantly impede a school from achieving its core mission—educating its students. Failure to prevent or quickly resolve air quality problems can:

- Increase the potential for short-term and long-term health problems such as asthma, the number one cause of student absenteeism.
- Increase the absentee rate of students, teachers, and staff.
- Decrease the productivity and attitude of students, teachers, and staff.
- Strain relationships among school administrators, students, teachers, parents, and staff.

VENTILATION

Since indoor air can be 2–5 times more polluted than outdoor air, most HVAC system designers understand that increased outdoor air supply is usually healthier. Yet there are concerns over the implications that this added amount of outdoor air supply has on the energy used by the HVAC system, as well as humidity control. As a result, school designers often try to regulate the amount of outdoor air to equal the minimum requirement for school classrooms of 15 cubic feet per minute (cfm) of outside air per person. This standard has been established by the American Society of Heating, Refrigerating and Air-conditioning Engineers (ASHRAE).

In some parts of the country, natural ventilation through operable windows can be an effective and energy-efficient way to supplement HVAC systems to provide outside air ventilation, cooling, and thermal comfort when conditions permit (temperature, humidity, outdoor air pollution levels, precipitation). Windows that open and close can enhance occupants' sense of well-being and feeling of control over their environment. They can also provide supplemental exhaust ventilation during renovation activities that may introduce pollutants into the space.

However, sealed buildings with appropriately designed and operated HVAC systems usually provide better indoor air quality than buildings with operable windows. Uncontrolled ventilation with outdoor air can allow outdoor air contaminants to bypass filters, potentially disrupt the balance of the mechanical ventilation equipment, and permit the introduction of excess moisture.

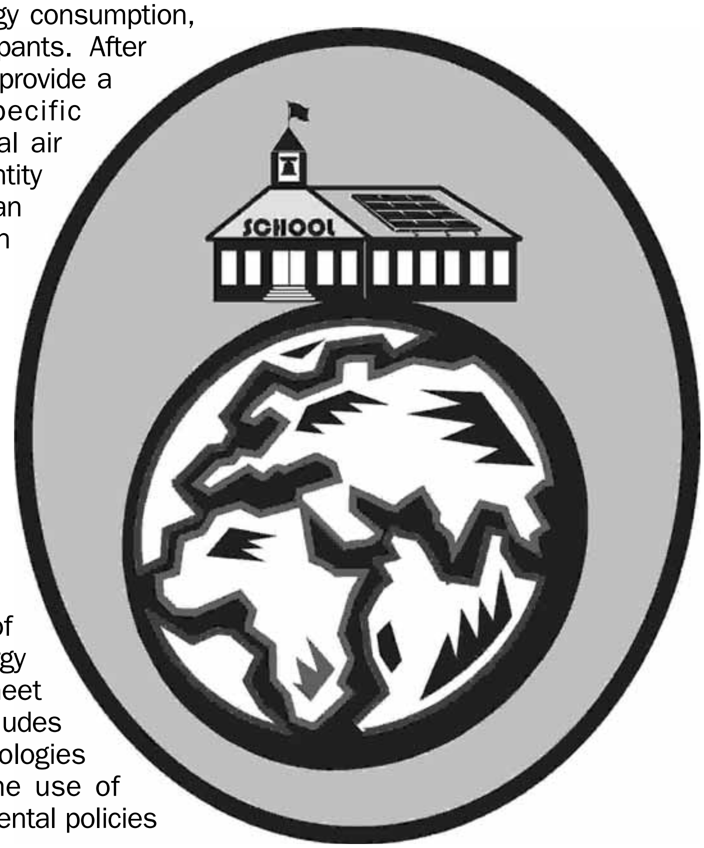
REGULATING MOISTURE AND RELATIVE HUMIDITY

Humidity is a measurement of the total amount of water vapor in the air. Relative humidity measures the amount of water vapor in the air relative to the amount of water vapor the air can hold, which depends on the temperature of the air. Air acts like a sponge and absorbs water through the process of evaporation. Warm air is less dense and the molecules are further apart, which allows more moisture to be contained between them. Cooler air causes the air molecules to draw closer together, limiting the amount of water the air can hold.

It is important to control moisture and relative humidity in occupied spaces. Relative humidity levels that are too high can contribute to the growth and spread of unhealthy biological pollutants. This in turn can lead to a variety of health effects, ranging from more common allergic reactions, to asthma attacks and other health problems. Humidity levels that are too low, however, can contribute to irritated mucous membranes, dry eyes, and sinus discomfort. Maintaining the relative humidity between 40 and 60 percent helps control mold. Maintaining relative humidity levels within recommended ranges is a way of ensuring that a building's occupants are both comfortable and healthy.

THE SCHOOL BUILDING AS A SYSTEM

When managing the systems of a school to minimize energy consumption, it's important to maintain the health and comfort of the occupants. After all, the reason energy is being used in the first place is to provide a good learning environment. Human beings have specific requirements for temperature, relative humidity, and general air quality. They also have requirements for the quality and quantity of lighting. If light levels are too low, or of poor quality, they can cause eyestrain, headaches, and safety issues. Energy can be saved by turning off lights and lowering the heat in winter, but doing so thoughtlessly can cause unsafe or unhealthy conditions in the building. When the building is treated as a system, energy is saved while maintaining or improving the indoor environment.



ENERGY SUSTAINABILITY

The school is not only a system in itself, but also a part of a global energy system that has finite energy resources. Energy efficiency and conservation are key components of energy **sustainability**—the concept that every generation should meet its energy needs without compromising the needs of future generations. Sustainability focuses on long-term energy strategies and policies that ensure adequate energy to meet today's needs as well as tomorrow's. Sustainability also includes investing in research and development of advanced technologies for producing conventional energy sources, promoting the use of alternative energy sources, and encouraging sound environmental policies and practices.

Energy Definitions & Conversions

DEFINITIONS

Current:	the flow of electrons—the number of electrons flowing past a fixed point. (measured in amperes–A)
Energy:	the ability to do work. Work involves a change in movement, temperature, energy level, or electrical charge. Energy is the ability to cause change. Work = force x distance. Work is measured in joules—a joule is the energy required to move an object with the force of one newton over a distance of one meter.
Electricity:	the energy of moving electrons. (measured in kilowatt-hours–kWh)
Force:	a push or pull that gives energy to an object, causing it to start moving, stop moving, or change direction. Force is measured in newtons—a newton is equal to the force needed to accelerate (move) a mass weighting one kilogram one meter in one second in a vacuum with no friction.
Voltage:	electric push or pressure—the energy available to move electrons. (measured in volts–V)
Watt:	the measure of electric power—the number of electrons moving past a fixed point in one second multiplied by the pressure or push of the electrons. (W = A x V)

CONVERSIONS

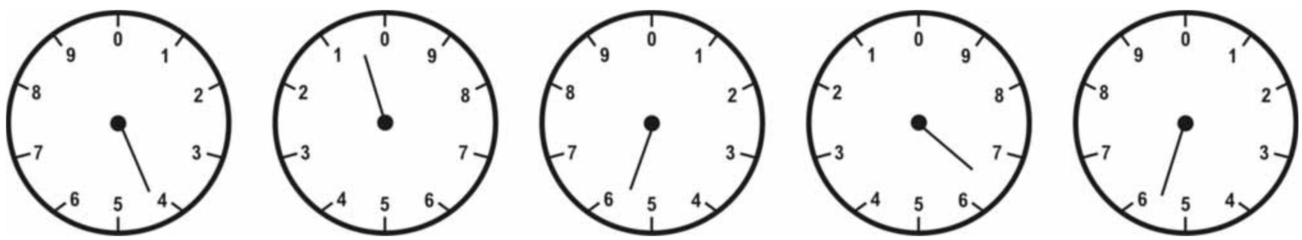
1 Btu =	British thermal unit—a measure of thermal energy (heat)—the amount of heat needed to raise the temperature of one pound of water by one degree Fahrenheit. One Btu is approximately the amount of energy released by the burning of one wooden kitchen match.
1 therm =	100,000 Btu—the amount of thermal energy in about one CCF of natural gas. One therm of natural gas costs between $1.00 and $2.00.
1 kWh =	Kilowatt-hour—one kilowatt of electricity over one hour. One kilowatt-hour of electricity is the amount of energy it takes to burn a 100-watt light bulb for 10 hours. The average cost of one kilowatt-hour of electricity for residential customers in the U.S. is about nine cents. The average cost for commercial customers, such as schools, is about eight cents.
1 kWh =	3,412 Btu
1 CF =	One cubic foot—a measure of volume—one CF of natural gas contains about 1,020 Btu of thermal energy.
1 CCF =	One hundred cubic feet—one CCF of natural gas contains about one therm of thermal energy. One CCF of natural gas costs between $1.00 and $2.00.
1 MCF =	One thousand cubic feet—one MCF of natural gas costs between $10 and $20.

Reading an Electric Meter

An electric company sends electricity to your home or school through a power line. There is a meter at the school to measure the amount of electricity that the school uses.

Reading an electric meter is easy. The face of the meter has five dials with the numbers 0 through 9 on each dial. The dials are not alike. On the first dial, the numbers are in a clock-wise direction. On the next meter, the numbers are in the opposite direction, in a counter clock-wise direction. The dials change from clock-wise to counter clock-wise, as shown below. If the pointer is between two numbers, you always record the smaller number. If the pointer is between 9 and 0, record 9, since 0 represents 10. Here are two examples with the correct numbers below the dials:

On Monday morning, this was the electric meter reading:



4 0 5 6 5

On Friday afternoon, this was the electric meter reading:

4 1 6 1 5

How much electricity was used this week? Subtract Monday's reading from Friday's reading:

41,615 – 40,565 = 1,050 kilowatt-hours

The electricity is measured in kilowatt-hours. If the power company charges a school ten cents ($0.10) for every kilowatt-hour (kWh) of electricity that is used, what is the cost of the electricity that was used in January?

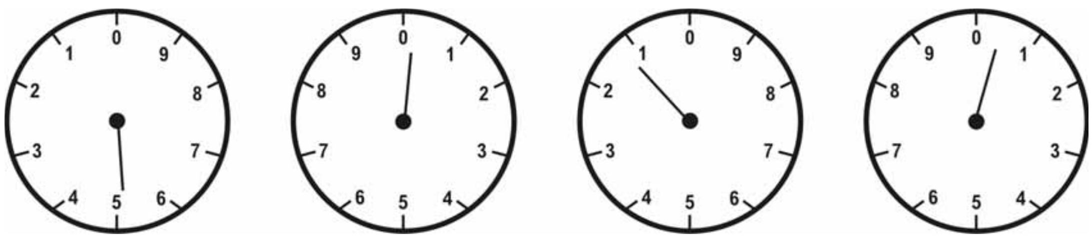
____________ kWh X $0.10/kWh = $ ______________________

Reading a Natural Gas Meter

A gas company delivers natural gas to a school through an underground pipeline. There is a meter at the school to measure the volume of natural gas that the school uses.

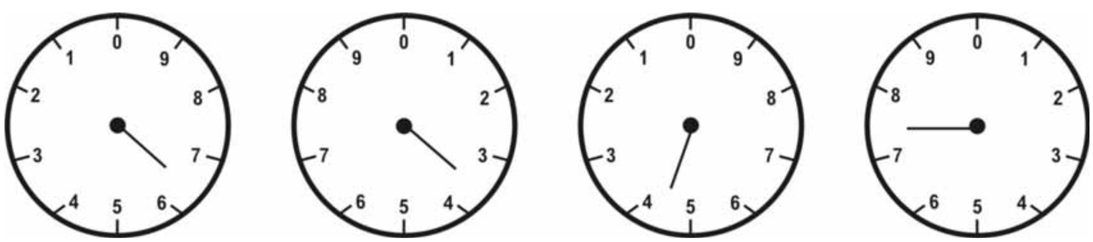
Reading a natural gas meter is much like reading an electric meter. The face of the meter has four dials with the numbers 0 through 9 on each dial. Notice that the dials are not alike. On two dials the numbers are in a clock-wise direction. On the other two, the numbers are in a counter clock-wise direction. Each dial changes from clock-wise to counter clock-wise, as shown below. If the pointer is between two numbers, you always record the smaller number. If the pointer is between 9 and 0, record 9, since 0 represents 10. Here are two examples with the correct numbers below the dials:

On December 1, this was the natural gas meter reading:



5 0 1 0

On January 1, this was the natural gas meter reading:



6 3 4 7

How much gas was used in December? Subtract the December 1st reading from the January 1st reading:

6,347 – 5,010 = 1,337 CCF

Natural gas is measured in CF or cubic feet—a measure of its volume. A cubic foot of natural gas is not much fuel, so most gas meters measure natural gas in hundreds of cubic feet—or CCF. The gas company measures the natural gas in CCF, but it charges by the amount of heat or thermal energy in the gas. The thermal energy is measured in **therms**.

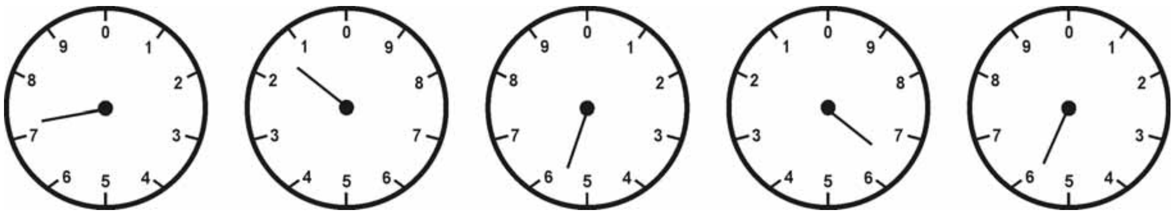
One CCF of natural gas contains about one therm of heat (1 CCF = 1 therm). If the gas company charges $1.34 for a therm of gas, how much did the gas cost in January?

Cost = ____________ therm X $1.34/therm = $ ________________

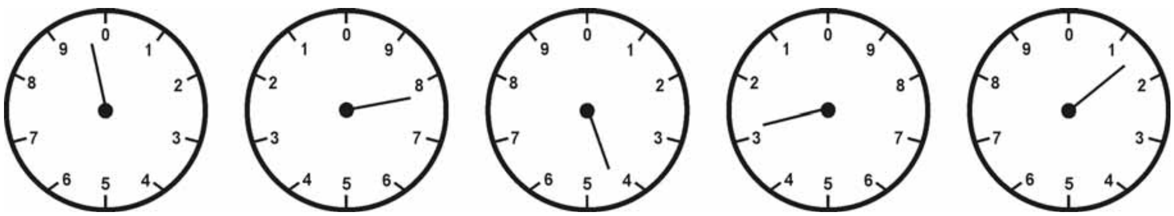
Reading Meters Worksheet

ELECTRIC METER

On January 1, this was the electric meter reading:



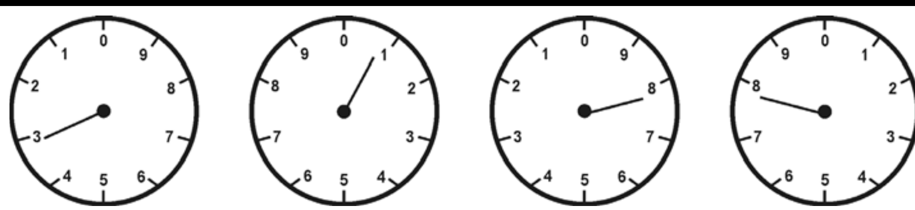
On January 31, this was the electric meter reading:



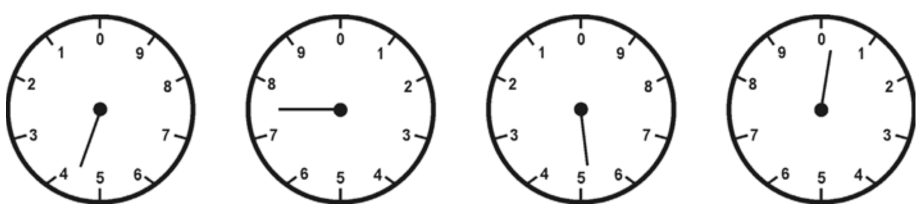
1. How many kilowatt-hours of electricity were used during January?
2. If the cost of electricity is $0.10 per kWh, how much did the electricity cost for January?
3. What was the average cost of electricity per day during January?

NATURAL GAS METER

On January 1, this was the natural gas meter reading:



On January 31, this was the natural gas meter reading:



1. How many CCF of natural gas were used during January?
2. If the cost of natural gas is $1.34 per therm and there were 1.025 therms per CCF, what was the cost of natural gas during January?
3. What was the average cost of natural gas per week during January?

Sample School Electric Bill

Nov 27, 2008 1

Customer Bill

ABC Elementary School
Anytown, USA

Your Electric Company

Billing and Payment Summary

Account # 000-1234 2 **Due Date: Jan 02, 2009** 3

Total Amount Due: $ 7,462.61 4

To avoid a Late Payment Charge of 1.5% please pay by Jan 02, 2009.

Previous Amount Due:	$ 8,152.93
Payments as of Nov 27:	$ 8,152.93

Meter and Usage

Current Billing Days: 34

Billable Usage

Schedule 130	*10/23 - 11/26*	12
Total kWh	12192	
Dist Demand	61.0	10
Demand	57.0	
Schedule 130	*10/23 - 11/26*	
Total kWh	69888	
Dist Demand	272.0	10
Demand	259.0	

Measured Usage 5

Meter: 000-1234	*0/23 - 11/26*	
Current Reading	4147	
Previous Reading	4020	
Total kWh	12192	6
Current Reading	.60	
Demand	57.60	11
Multiplier: 96		
Meter: 111-4567	*0/23 - 11/26*	
Current Reading	51746	
Previous Reading	51382	
Total kWh	69888	6
Current Reading	1.35	
Demand	259.20	11
Multiplier: 192		

Usage History

Explanation of Bill Detail

Your Electric Company 1-800-123-4567

	Previous Balance	8,152.93	
	Payment Received	8,152.93	
	BALANCE FORWARD	0	
	Non-Residential Service (Schedule 130)	*10/23 - 11/26*	
	Distribution Service		
	Basic Customer Charge	86.52	
	Distribution Demand	206.29	
13	Electricity Supply Service (ESS)		
	ESS Adjustment Charge	83.93 CR	
	Electricity Supply kWh	214.94	
	ESS Demand Charge	558.85	7
	Fuel Charge	353.81	
	Sales and Use Surcharge	2.68	8
	Non-Residential Service (Schedule 130)	*10/23 - 11/26*	
14	Distribution Service		
	Basic Customer Charge	86.52	
	Distribution Demand	919.87	
	Electricity Supply Service (ESS)		
	ESS Adjustment Charge	374.243 CR	
	Electricity Supply kWh	909.41	
	ESS Demand Charge	2,539.36	7
	Fuel Charge	2,058.15	
	Sales and Use Surcharge	13.38	8
	TOTAL CURRENT CHARGES	**7,463.61**	9
	TOTAL ACCOUNT BALANCE	**7,463.61**	4

For service emergencies and power outages, call 1-800-123-4567.

Mailed on Nov 28, 2007

Please detach and return this payment coupon with your check made payable to Your Electric Company.

Bill Date Nov 27, 2008 1

Payment Coupon

Please Pay by 01/02/2009 3
$ 7,463.54 4

Amount Enclosed

Account # 000-1234 2

Send payment to:

ABC Elementary School
123 Main Street
Anytown, USA 98765

Your Electric Company
PO BOX 123456
Anytown, USA 98765

01166005000 000000009368 6868686 0001234 11272007

Sample School Natural Gas Bill

ABC Elementary School
Anytown, USA

NOTE: The bill you received on or around Friday, Nov., Nov. 2 was calculated using estimated usage instead of the actual meter reading. This invoice reflects your actual meter reading. If your new amount due is more than what was indicated on your previous bill, please remit payment for the difference. If it is less, and you've already paid, the difference will be credited to your account and shown on your next bill. We apologize for the inconvenience.

1 Account Number	2 Billing Date	3 Next Meter Reading	4 Next Billing Date
000-12345678	Nov 15, 2008	Dec 3, 2008	Dec 4, 2008

Visit our web site at www. yourgascompany.com

If you have any questions call 1-800-000-0000

Credits & Charges Since Your Last Bill

Payments Received - Thank You	$1,302.60 CR	5
Outstanding Balance	$0.00	

Current Charges

General Service

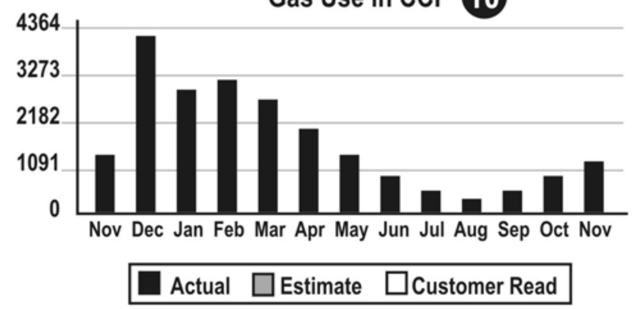
Delivery	6	282.14
Gas Supply	7	1,377.91
Total Current Charges		**$1,660.05**
Total Account Balance	8	**$1,660.05**

For Gas Leaks, call 1-800-123-4567

Monthly Usage Comparison

Heating Degree Days For This Billing Period	2006	9	2007	NORMAL
	160		51	138

Gas Use in CCF 10



Billing Period and Meter Readings

Date	Read Type	Reading
October 30, 2007	Actual	70320
October 01, 2007	Actual	68985

11

CCF used in 29 days: 1335 12
Meter Number 123456 13

Please pay by Dec 10, 2007, To Avoid A Late Charge of 1.5% Per Month

EnergyShare has helped Virginians pay heating bills of all kinds. You can help by adding $1, $2, $5, $10, $15, or $20 to your gas bill payment. 14

Please make checks payable to Your Gas Company and return this portion with your payment. Thanks!

YOUR GAS COMPANY
PO Box 123456 Anytown, USA 98765

PREVIOUS BALANCE	**$0.00**	
Total Current Charges	**$1,660.05**	**Pay By Dec 10, 2008** 15
Total Account Balance	**$1,660.05**	
Account # 000-12345678	Amount Enclosed	16

ABC Elementary School
123 Main Street
Anytown, USA 98765

Your Gas Company
PO BOX 123456
Anytown, USA 98765

01166005000000000000093686868686000 12345678

Sample Bill Explanation Key

SAMPLE SCHOOL ELECTRIC BILL EXPLANATION

1. Bill Mailing Date.
2. Customer Account Number.
3. Payment Due Date.
4. Total Amount Due.
5. Meter Readings By Date in Kilowatt-hours. Note that there are two meters on this bill.
6. Actual Kilowatt-hours Consumed.
7. Cost of the Electricity Consumed.
8. Sales and Use Surcharge.
9. Total Current Charges.
10. Demand. This is a measurement of the rate at which electricity is used. The monthly demand is based on the 15 minutes during a billing period with the “highest average” kW use. Demand charges are designed to collect some of the generation and transmission-related costs necessary to serve a particular group or class of customers.
11. Actual Demand for the meter.
12. Schedule 130 is a rate class that determines how much is paid per kWh of uage and kW demand.
13. Electricity Supply Service. Customers are billed for the electricity supply and the delivery of the electricity. The supply charge reflects the cost of generating the electricity at the power plant.
14. Distribution Service. The delivery charge reflects the cost of delivering the electricity from the power plant to the customer.

SAMPLE SCHOOL NATURAL GAS BILL EXPLANATION

1. Customer Account Number.
2. Date of the Bill.
3. Date of Next Meter Reading.
4. Date of the Next Bill.
5. Last Payment Received.
6. Charge for Delivering the Natural Gas to the School.
7. Charge for the Natural Gas.
8. Total Amount Due.
9. Comparison of Heating Degree Days. Degree day is a quantitative index that reflects demand for energy to heat or cool buildings. This index is derived from daily temperature observations at nearly 200 major weather stations in the contiguous United States. The heating year during which heating degree days are accumulated extends from July 1st to June 30th. A mean daily temperature (average of the daily maximum and minimum temperatures) of 65°F is the base for both heating and cooling degree day computations. Heating degree days are summations of negative differences between the mean daily temperature and the 65°F base.
10. Graph of Actual Gas Used by Month for the Last Year.
11. The Actual Meter Readings for the Month.
12. The Volume of Gas Used in CCF.
13. The Meter Number.
14. EnergyShare Fund. Most utilities are associated with a fuel fund for needy customers; paying customers can contribute any amount to the fund and note it here.
15. Due Date of Payment.
16. Amount Enclosed by Customer.

Electric Nameplates

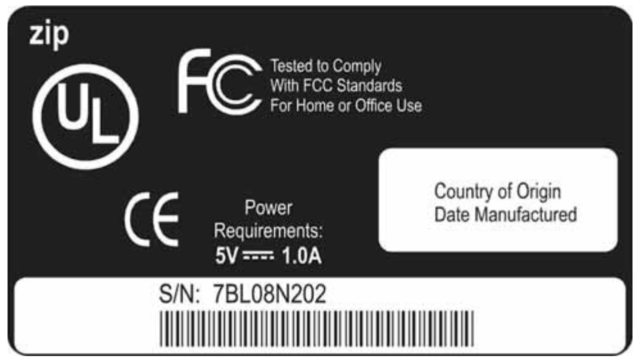
CHANGE FOR THE BETTER WITH ENERGY STAR

Some appliances use more energy than others to accomplish the same task. Appliances that are very energy efficient are approved by the government's ENERGY STAR® program and have the ENERGY STAR® label on them. This means they have met high standards set by the government for energy efficiency.

Every machine that runs on electricity has an **electric nameplate** on it. The nameplate is usually a silver sticker that looks like the picture below. The nameplate has information about the amount of electricity the machine uses. Sometimes, the current is listed. The current is measured in amperes (A). Sometimes, the voltage the machine needs is listed. The voltage is listed in volts (V). Sometimes, the wattage is listed. The wattage is measured in watts (W). If the wattage isn't listed, then the current and voltage are both listed.

If the wattage isn't listed, you can calculate the wattage using the following formula, like this:

wattage	**=**	**current**	**x**	**voltage**
W	**=**	**A**	**x**	**V**
W	**=**	**1.0A**	**x**	**5V**
W	**=**	**5W**		



Often, the letters UL are on the nameplate. UL stands for Underwriters Laboratories, Inc., which conducts tests on thousands of machines and appliances. The UL mark means that samples of the machines and appliances have been tested to make sure they are safe.

You can find out how much it costs to operate any appliance or machine if you know the wattage. Take a look at some of the machines in your school. The nameplate is usually located on the bottom or back. See if you can find the nameplates on the computers, printers, monitors, televisions, and other machines in your classroom. Put the information in the chart below and figure out the wattage for each one.

Machine	Current	Voltage	Wattage	UL tested
Copier	11 A	115 V	1,265 W	yes

Cost of Using Machines

Calculate how much it costs to operate the machines in your classroom that you looked at before. You need to know the wattage, the cost of electricity, and the number of hours a week each machine is used.

You can estimate the number of hours the machine is used each week, then multiply by 40 to get the yearly use. We're using 40 weeks for schools, because school buildings aren't used every week of the year. Using the copier as an example, if it is used for ten hours each week, we can find the yearly use like this:

Yearly use = 10 hours/week x 40 weeks/year = 400 hours/year

Remember that electricity is measured in kilowatt-hours. You will need to change the watts to kilowatts. One kilowatt is equal to 1,000 watts. To get kilowatts, you must divide the watts by 1,000. Using the copier as an example, divide like this:

kW = W/1000

kW = 1265/1000 = 1.265

The average cost of electricity for schools in the U.S. is about eight cents a kilowatt-hour. You can use this rate or find out the actual rate from your school's electric bill. Using the average cost of electricity, we can figure out how much it costs to run the copier for a year by using this formula:

Yearly cost	=	**Hours used**	x	**Kilowatts**	x	**Cost of electricity (kWh)**
Yearly cost	=	**400 hours/year**	x	**1.265 kW**	x	**$0.10/kWh**
Yearly cost	=	**400 x 1.265**	x	**0.10**	=	**$50.60**

Machine or Appliance	Watts W	Kilowatts kW	Hours a week	Hours a year	Rate $/kWh	Yearly Cost
Copier	1,265 W	1.265 kW	10	400	$0.10	$50.60

Environmental Impacts

When we breathe, we produce carbon dioxide. When we burn fuels, we produce carbon dioxide, too. Carbon dioxide (CO_2) is a greenhouse gas. Greenhouse gases hold heat in the atmosphere. They keep our planet warm enough for us to live. But in the last 200 years, we have been producing more carbon dioxide than ever before.

Research shows that greenhouse gases are trapping more heat in the atmosphere. Scientists believe this is causing the average temperature of the earth's atmosphere to rise. They call this global climate change or global warming. Global warming refers to an average increase in the temperature of the atmosphere, which in turn causes changes in climate. A warmer atmosphere may lead to changes in rainfall patterns, a rise in sea level, and a wide range of impacts on plants, wildlife, and humans. When scientists talk about the issue of climate change, their concern is about global warming caused by human activities.

Driving cars and trucks produces carbon dioxide because fuel is burned. Heating homes by burning natural gas, wood, heating oil, or propane produces carbon dioxide, too.

Making electricity can also produce carbon dioxide. Some energy sources—such as hydropower, solar, wind, geothermal, and nuclear—don't produce carbon dioxide because no fuel is burned. Half of our electricity, however, comes from burning coal. Another 20 percent comes from burning natural gas, petroleum, and biomass.

The general rule is that—on average—every kilowatt-hour of electricity produces 1.6 pounds of carbon dioxide. Let's use this rule to figure out how much carbon dioxide is produced by the machines in your classroom. You can put the figures from the earlier worksheets in the boxes below. Here are the figures for the copier:

CO_2 a year = wattage x hours of use x rate of CO_2/kWh

CO_2 a year = 1.265 kW x 400 hr/yr x 1.6 lb/kWh = 809.6 lb

Machine or Appliance	Wattage kW	CO_2/kWh lbs	Hours/year hr	CO_2/year lbs
Copier	1.265	1.6	400	809.6

EnergyGuide Labels

The Federal government requires that appliance manufacturers provide information about the energy efficiency of their products to consumers so that they can compare the life cycle cost of the appliances, as well as the purchase price. The life cycle cost of an appliance is the purchase price plus the operating cost over the projected life of the appliance.

The law requires that manufacturers place EnergyGuide labels on all new refrigerators, freezers, water heaters, dishwashers, clothes washers, room air conditioners, central air conditioners, heat pumps, and furnaces and boilers. The EnergyGuide labels list the manufacturer, the model, the capacity, the features, the amount of energy the appliance will use a year on average, its comparison with similar models, and the estimated yearly energy cost.

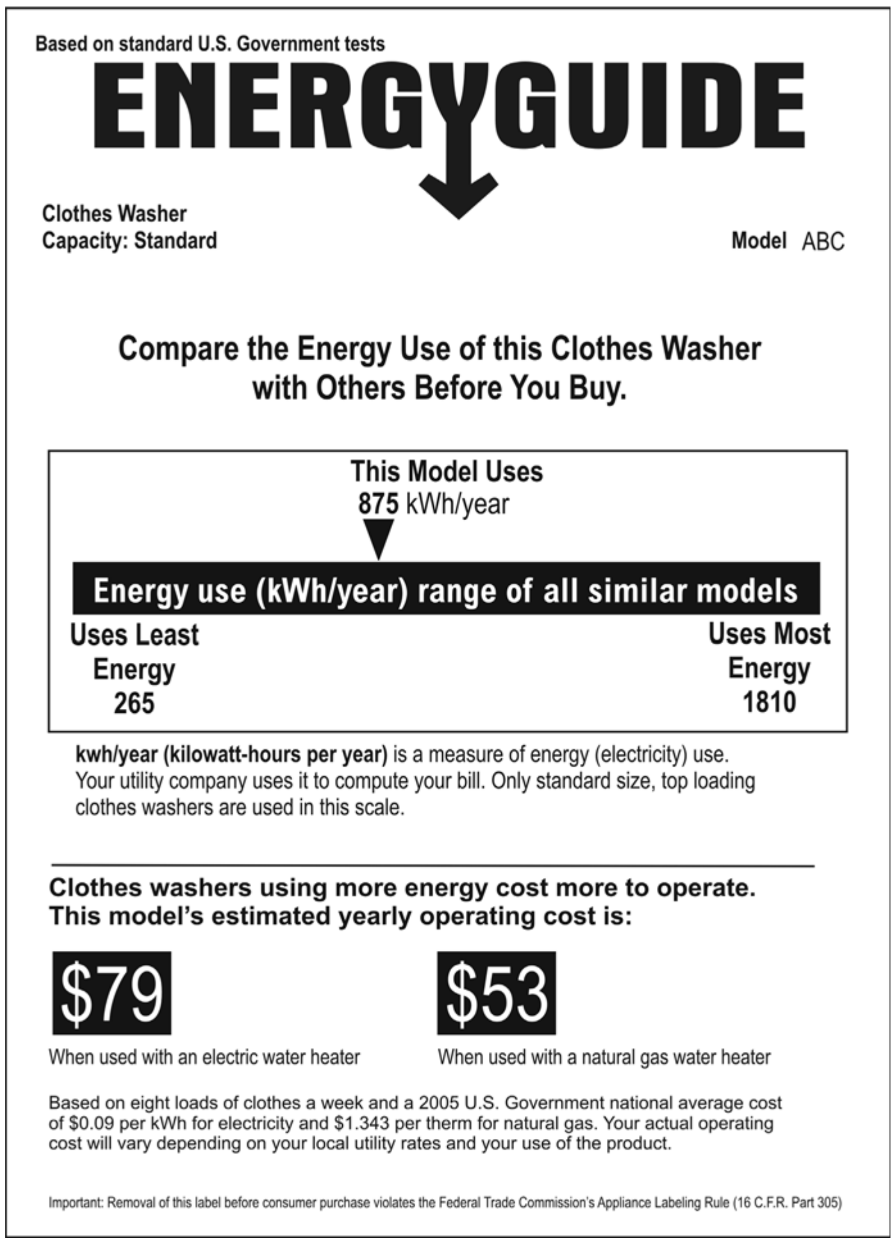
For refrigerators, freezers, water heaters, dishwashers, and clothes washers, the labels compare energy consumption in kWh/year or therms/year. For room air conditioners, central air conditioners, heat pumps, and furnaces and boilers, the rating is not in terms of energy consumption, but in energy efficiency ratings, as follows:

EER: Energy Efficiency Rating
(room air conditioners)

SEER: Seasonal Energy Efficiency Rating
(central air conditioners)

HSPF: Heating Season Performance Factor–with SEER
(heat pumps)

AFUE: Annual Fuel Utilization Efficiency
(furnaces and boilers)


Based on standard U.S. Government tests

ENERGYGUIDE

Clothes Washer
Capacity: Standard

Model ABC

Compare the Energy Use of this Clothes Washer with Others Before You Buy.

This Model Uses
875 kWh/year

Energy use (kWh/year) range of all similar models

Uses Least Energy 265

Uses Most Energy 1810

kwh/year (kilowatt-hours per year) is a measure of energy (electricity) use. Your utility company uses it to compute your bill. Only standard size, top loading clothes washers are used in this scale.

Clothes washers using more energy cost more to operate. This model's estimated yearly operating cost is:

$79
When used with an electric water heater

$53
When used with a natural gas water heater

Based on eight loads of clothes a week and a 2005 U.S. Government national average cost of $0.09 per kWh for electricity and $1.343 per therm for natural gas. Your actual operating cost will vary depending on your local utility rates and your use of the product.

Important: Removal of this label before consumer purchase violates the Federal Trade Commission's Appliance Labeling Rule (16 C.F.R. Part 305)

CLOTHES WASHER
On the right is an EnergyGuide label from an average energy–using clothes washer. Notice how much more it costs to run the washer if you have an electric water heater than if you have a natural gas water heater.

Comparing Appliances

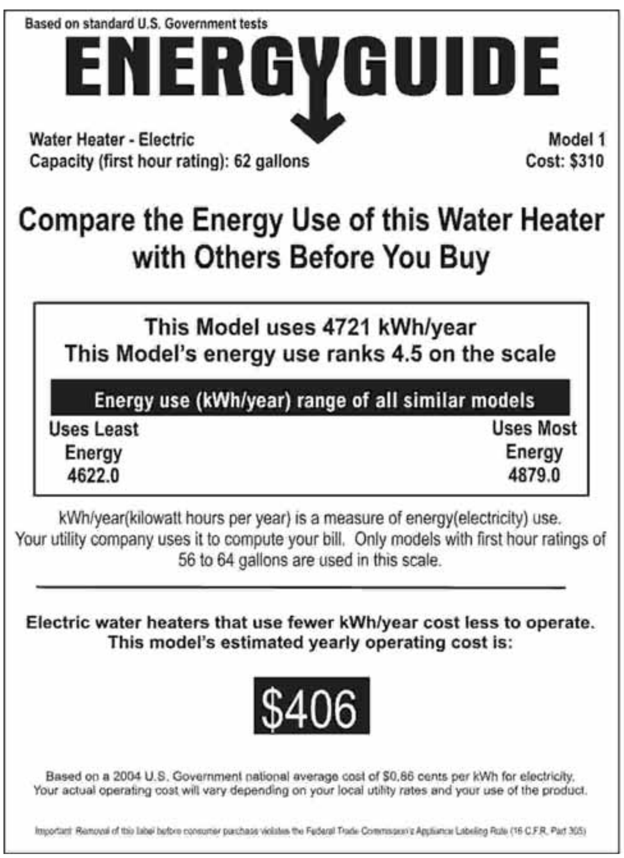
Your parents need to buy a new water heater. You need to help them choose the better one. Water heaters usually last a long time—10 to 20 years—so you can save a lot of money on an energy-efficient one. Use the chart below to calculate which water heater to buy.

How many years will it take before you begin to save money?

How much money will you have saved after eight years?

Water Heater 1: $310 **Water Heater: $330**

Model 1	Expenses	Cost to Date	Model 2	Expenses	Cost to Date
Purchase Price			Purchase Price		
Year One			Year One		
Year Two			Year Two		
Year Three			Year Three		
Year Four			Year Four		
Year Five			Year Five		
Year Six			Year Six		
Year Seven			Year Seven		
Year Eight			Year Eight		


Based on standard U.S. Government tests

ENERGYGUIDE

Water Heater - Electric
Capacity (first hour rating): 62 gallons

Model 1
Cost: $310

Compare the Energy Use of this Water Heater with Others Before You Buy

This Model uses 4721 kWh/year
This Model's energy use ranks 4.5 on the scale

Energy use (kWh/year) range of all similar models

Uses Least Energy 4622.0

Uses Most Energy 4879.0

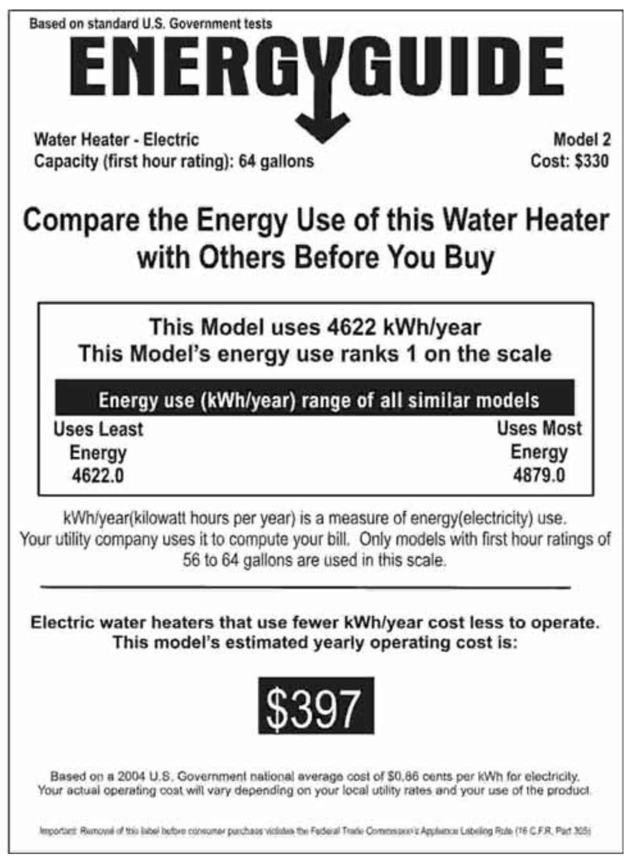
kWh/year(kilowatt hours per year) is a measure of energy(electricity) use. Your utility company uses it to compute your bill. Only models with first hour ratings of 56 to 64 gallons are used in this scale.

Electric water heaters that use fewer kWh/year cost less to operate. This model's estimated yearly operating cost is:

$406

Based on a 2004 U.S. Government national average cost of $0.86 cents per kWh for electricity. Your actual operating cost will vary depending on your local utility rates and your use of the product.

Important: Removal of this label before consumer purchase violates the Federal Trade Commission's Appliance Labeling Rule (16 C.F.R. Part 305)


Based on standard U.S. Government tests

ENERGYGUIDE

Water Heater - Electric
Capacity (first hour rating): 64 gallons

Model 2
Cost: $330

Compare the Energy Use of this Water Heater with Others Before You Buy

This Model uses 4622 kWh/year
This Model's energy use ranks 1 on the scale

Energy use (kWh/year) range of all similar models

Uses Least Energy 4622.0

Uses Most Energy 4879.0

kWh/year(kilowatt hours per year) is a measure of energy(electricity) use. Your utility company uses it to compute your bill. Only models with first hour ratings of 56 to 64 gallons are used in this scale.

Electric water heaters that use fewer kWh/year cost less to operate. This model's estimated yearly operating cost is:

$397

Based on a 2004 U.S. Government national average cost of $0.86 cents per kWh for electricity. Your actual operating cost will vary depending on your local utility rates and your use of the product.

Important: Removal of this label before consumer purchase violates the Federal Trade Commission's Appliance Labeling Rule (16 C.F.R. Part 305)

Facts of Light

We use a lot of energy to make light so that we can see. In schools, about 25 percent of the energy is used for lighting and, in homes, about ten percent.

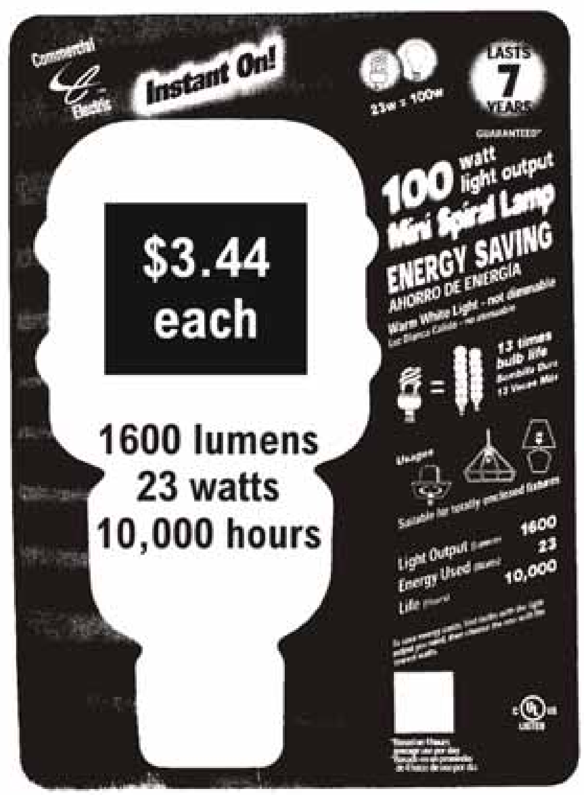
Most homes use incandescent lightbulbs, the bulbs developed by Thomas Edison. These bulbs are not energy-savers. They change 90 percent of the electricity into heat instead of light. If everyone used new compact fluorescent lightbulbs, we could lower our energy bill for lighting by 70 percent.

Compact fluorescent lights (CFLs) use less energy than incandescent bulbs and last much longer. Over the life of the bulbs, CFLs cost less to produce the same amount of light. CFLs also produce very little heat. The chart below shows how using CFLs can save money. Even though the bulbs cost more, they last much longer and use less energy. Life cycle cost is the cost of the bulb plus the cost of the energy to operate it over its useful life.

Most schools and businesses use fluorescent tube lights. New tube lights are very energy efficient. They provide a lot of light without using a lot of energy. Many schools are saving a lot of money by changing their old lights to new energy-efficient fluorescent tube lights.

INCANDESCENT

CFL

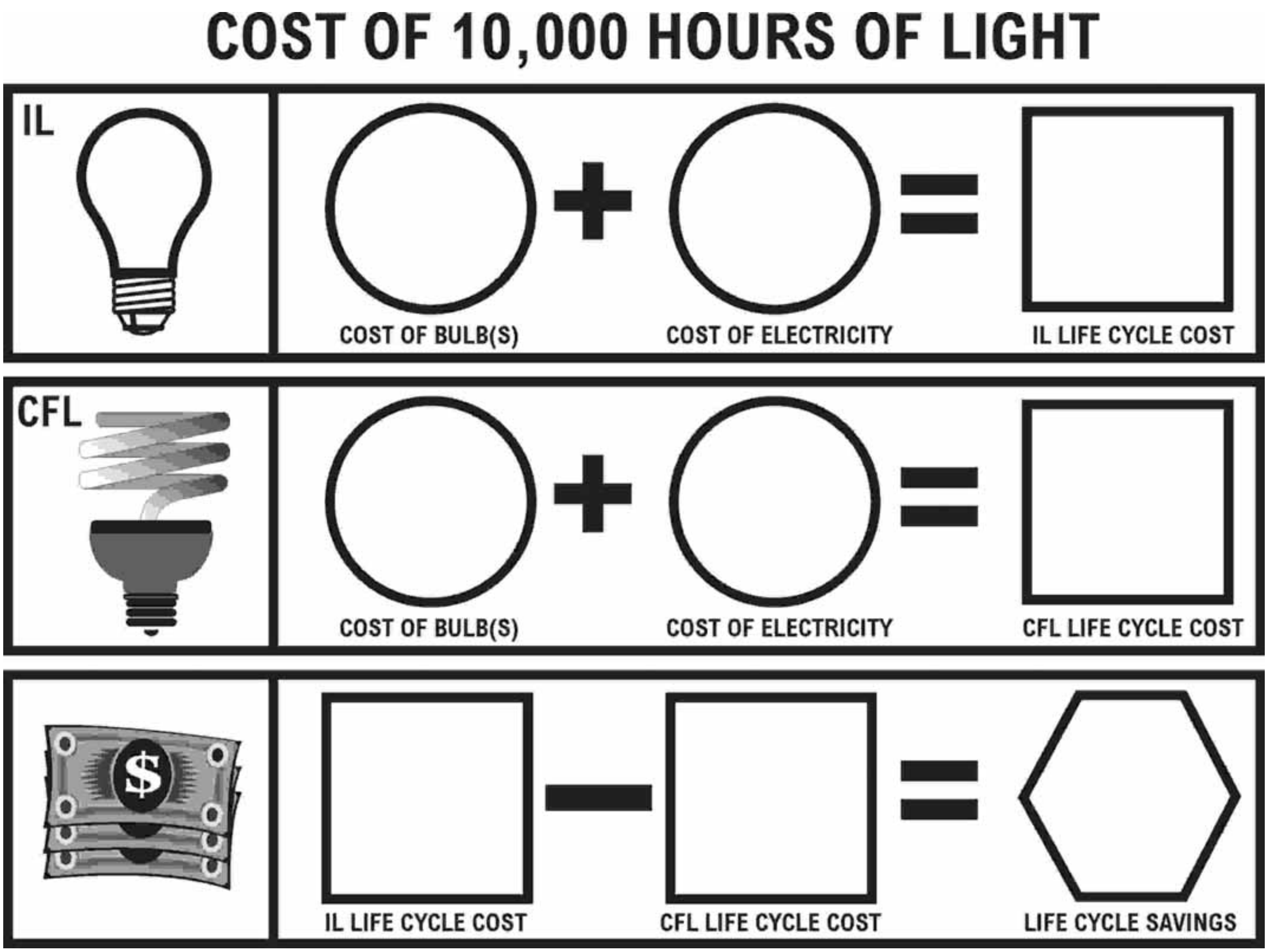


Comparing Lightbulbs

HOW MUCH CAN YOU SAVE WITH CFLs?

The graphic on the previous page shows the packaging from two bulbs that produce the same amount of light. You might put bulbs like these into a bright overhead light. One bulb is an incandescent lightbulb (IL); the other is a compact fluorescent lightbulb (CFL). Which one is the better bargain? Let's do the math and compare the two lightbulbs using the residential cost of electricity at $0.11/kWh.

1. Determine how many bulbs you will need to produce 10,000 hours of light by dividing 10,000 by the number of hours each bulb produces light.
2. Determine the cost of each bulb by dividing the cost of a package of bulbs by the number of bulbs in the package.
3. Multiply the number of bulbs you will need by the cost of each bulb to determine the cost of bulbs to produce 10,000 hours of light.
4. Multiply the wattage of the bulbs by 10,000 hours to determine watt-hours (Wh), then divide by 1,000 to determine the number of kilowatt-hours (kWh).
5. Multiply the number of kilowatt-hours by the cost per kilowatt-hour to determine the cost of electricity to produce 10,000 hours of light.

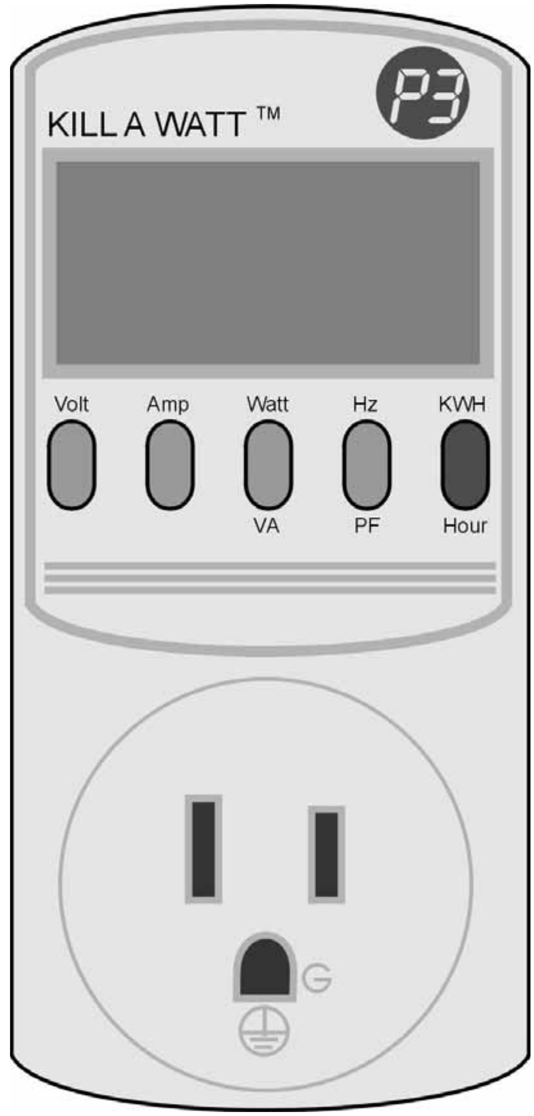


Kill A Watt™ Monitor

The Kill A Watt™ monitor allows users to measure and monitor the power consumption of any standard electrical device. You can obtain instantaneous readings of voltage (volts), current (amps), line frequency (Hz), and electrical power being used (watts). You can also obtain the actual amount of power consumed in kilowatt-hours (kWh) by any electrical device over a period of time from 1 minute to 9,999 hours. One kilowatt equals 1,000 watts.

OPERATING INSTRUCTIONS

1. Plug the Kill A Watt monitor into any standard grounded outlet or extension cord.
2. Plug the electrical device or appliance to be tested into the **AC Power Outlet Receptacle** of the Kill A Watt™ monitor.
3. The **LCD** displays all monitor readings. The unit will begin to accumulate data and powered duration time as soon as the power is applied.
4. Press the **Volt** button to display the voltage (volts) reading.
5. Press the **Amp** button to display the current (amps) reading.
6. The **Watt** and **VA** button is a toggle function key. Press the button once to display the Watt reading; press the button again to display the VA (volts x amps) reading. The Watt reading, not the VA reading, is the value used to calculate kWh consumption.
7. The **Hz** and **PF** button is a toggle function key. Press the button once to display the Frequency (Hz) reading; press the button again to display the Power Factor (PF) reading.
8. The **KWH** and **Hour** button is a toggle function key. Press the button once to display the cumulative energy consumption. Press the button again to display the cumulative time elapsed since power was applied.



WHAT IS POWER FACTOR (PF)?

We often use the formula **Volts x Amps = Watts** to find the energy consumption of a device. Many AC devices, however, such as motors and magnetic ballasts, do not use all of the power provided to them. The Power Factor (PF) has a value equal to or less than one, and is used to account for this phenomenon. To determine the actual power consumed by a device, the following formula is used:

VOLTS X AMPS X PF = WATTS CONSUMED

Kill A Watt 1

Utility companies measure power consumption in kilowatt-hours (kWh). One 100-watt lightbulb consumes 1 kWh (or 1,000 Wh) of electricity in ten hours. If the bulb is turned on an average of 80 hours a month, it consumes 8.0 kWh/month. To determine annual cost, multiply the kWh per month by the number of months used per year by the cost per kWh:

kWh/month x month/year x cost/kWh

The average cost of a kWh of electricity for residential consumers is $0.11 (8 kWh/month x 12 months/year x $0.11/kWh = $10.56/year). The average cost of a kWh of electricity for commercial consumers such as schools is $0.10 (8 kWh/month x 9 months/year x $0.10/kWh = $7.20/year).

GOAL: To determine how much power selected electrical devices use per year.

PROCEDURE: Select several different electrical devices in the school and estimate the number of hours they are in use per month and the number of months they are in use per year. Record these estimates in the table below.

Use the Kill A Watt monitor to measure the watts used by the device. Multiply this value by the number of hours the devices are used per month, then by the number of months in use per year. This gives you watt-hours/year of usage.

Divide watt-hours/year by 1000 to determine kWh/year.

Multiply the kWh/year by the average rate of a kWh of electricity for schools to calculate the yearly cost of using the devices.

RESULTS: Record your measurements and calculations in the table below.

Electrical Device	Hours in use per month	Months in use per year	Watts measured	kWh used per year	Cost per kWh	Cost per Year
laptop	*100*	*10*	*20*	*20.0*	*$0.10*	*$2.00*

CONCLUSIONS:

Which electrical device uses the most electricity per hour?

Which electrical device uses the least electricity per hour?

Which electrical device uses the most electricity each year?

Which electrical device uses the least electricity each year?

Kill A Watt 2

Some electrical devices appear to use more power when they are in active mode than when they are in idle mode. These devices include pencil sharpeners, copiers and printers, clock radios and others. In addition, some devices such as fans appear to use more power at high speeds than at low speeds.

The Kill A Watt monitor can be used to measure the power consumption of these electrical devices to determine the difference in consumption when these devices are operating in different modes.

GOAL: To determine if electrical devices use different amounts of power when they are in different modes or operated at different speeds.

PROCEDURE: Select several electrical devices that might consume power at different rates while active and idle or while operating at different speeds. Use the Kill A Watt monitor to measure the watts used in different modes of operation and record in the table below.

Estimate the average number of hours per week each device is in active use and the average number of hours per week the device is turned on, but idle, by interviewing users. Estimate the values with devices that can operate at different speeds. Multiply these values by 52 (all year) or 40 (40-week school year) to calculate the average yearly amount of time each device is in use in each mode. Multiply the kWh/year value by the average rate of a kWh of electricity for your school to calculate the annual cost of the devices in each mode. Adding the two costs together will give you the total cost of using the device.

RESULTS: Record your measurements and calculations in the table below.

Electrical Device	Hours in use per week	Weeks in use per year	Watts measured	kWh used per year	Cost per kWh	Cost per Year
copier - idle	*36*	*40*	*20*	*28.8*	*$0.10*	*$2.88*
copier - active	*4*	*40*	*1200*	*192.0*	*$0.10*	*$19.20*
fan - low						
fan - high						

CONCLUSIONS:

Do some devices use more power when they are active than when they are idle?

Do some devices use more power on high speed than on low speed?

Note: Because some electrical devices cycle on and off without our control, the most accurate way to determine actual power consumption is to use the Kill A Watt monitor to measure consumption over a 12–24 hour period. Refrigerators, for instance, cycle on and off in response to internal temperature sensors.

Kill A Watt 3

Many electrical devices continue to use power when they are in the OFF position. These devices have what are called "phantom" loads, and include microwaves, coffee makers, televisions, VCRs, DC power supplies and chargers, and computers. Devices with LCD or LED displays such as timers and clocks, for example, also use power even when they are turned OFF or are in SLEEP mode. The Kill A Watt monitor can be used to measure the phantom loads of electrical devices.

GOAL: To determine if some electrical devices use power even when they are in the off position.

PROCEDURE: Select all of the electrical devices in the room that might consume power even when they are turned off or in sleep mode. Use the Kill A Watt monitor to measure the watts used when the device is in the ON, OFF, and SLEEP modes. Record the measurements in the table below.

Estimate the average number of hours per week each device is in the ON, OFF, and SLEEP modes. Multiply these values by 52 (all year) or 40 (40-week school year) to calculate the average yearly amount of time each device is in use in each mode. Multiply the kWh/year values by the average rate of a kWh of electricity for your school to calculate the annual cost of the devices.

RESULTS: Record your measurements and calculations in the table below.

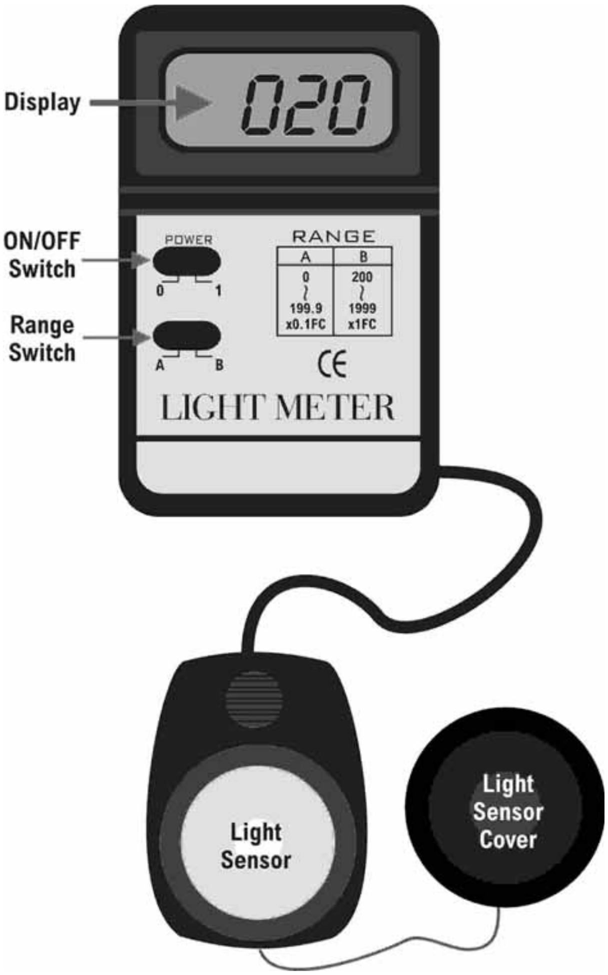
Electrical Device	Hours in use per week	Weeks in use per year	Watts measured	kWh used per year	Cost per kWh	Cost per Year
television - on	*10*	*52*	*70*	*36.4*	*$0.10*	*$3.64*
television - off	*158*	*52*	*5*	*41.1*	*$0.10*	*$4.11*

CONCLUSIONS:

Do some devices use power when they are in the OFF or SLEEP mode?

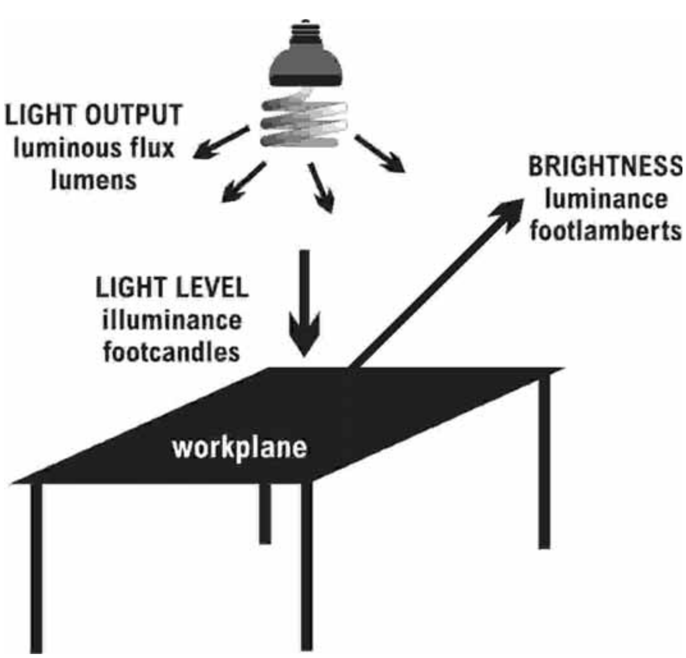
How much money could be saved per year by unplugging all of the devices in the room when they are in the OFF or SLEEP mode?

The Light Meter



OPERATING INSTRUCTIONS

1. Insert the battery into the battery compartment in the back of the meter.
2. Slide the ON/OFF Switch to the ON position.
3. Slide the Range Switch to the B position.
4. On the back of the meter, pull out the meter's tilt stand and place the meter on a flat surface in the area you plan to measure.
5. Hold the Light Sensor so that the white lens faces the light source to be measured or place the Light Sensor on a flat surface facing the direction of the light source.
6. Read the measurement on the LCD Display.
7. If the reading is less than 200 fc, slide the Range Switch to the A position and measure again.



LIGHT OUTPUT OR LUMINOUS FLUX

A lumen (lm) is a measure of the light output (or *luminous flux*) of a light source (bulb or tube). Light sources are labeled with output ratings in lumens. A T-12 40-watt fluorescent tube light, for example, may have a rating of 3050 lumens.

LIGHT LEVEL OR ILLUMINANCE

A footcandle (fc) is a measure of the quantity of light (illuminance) that actually reaches the workplane on which the light meter is placed. Footcandles are *workplane lumens per square foot*. The light meter can measure the quantity of light from 0 to 1000 fc.

BRIGHTNESS OR LUMINANCE

Another measure of light is its brightness or *luminance*. Brightness is a measure of the light that is reflected from a surface in a particular direction. Brightness is measured in footlamberts (fL).

Recommended Light Levels

Below is a list of recommended illumination levels for school locations in footcandles.

AREA	FOOTCANDLES
Classrooms-general	50-75
Classrooms-art	50-75
Classrooms-computer	50-75
Classrooms-drafting	75-100
Classrooms-sewing	75-100
Labs-general	50-75
Labs-demonstrations	100-150
Auditorium seating areas	10-15
Auditorium concerts on stage	50-75
Kitchens	50-75
Cashiers	20-30
Dishwashing areas	20-30
Dining areas	10-20
Corridors & stairwells-elementary	10-15
Corridors & stairwells-middle	20-30
Corridors & stairwells-high	20-30
Gymnasiums	20-30
Media centers	50-75
Offices	75-100
Teacher workrooms	30-50
Conference rooms	30-50
Washrooms	20-30
Building exteriors & parking lots	1-2

Lightbulb Investigation 1

GOAL: To compare the heat output of an incandescent to a compact fluorescent lightbulb.

MATERIALS: 2 lamps, 1 incandescent lightbulb, 1 compact fluorescent bulb, 2 thermometers, tape

PREPARATION: Read all of the steps in the procedure.

Write your hypothesis below:

HYPOTHESIS:

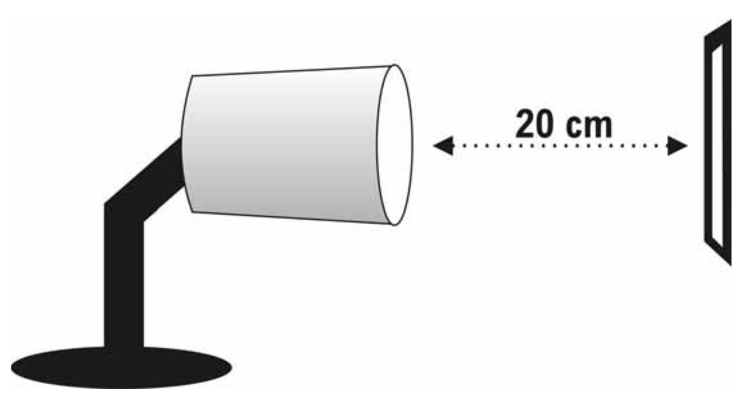
PROCEDURE:

1. Place the incandescent bulb in one lamp and the compact fluorescent bulb in the other.
2. Place the lamps on a table about 40 cm apart facing a blank wall.
3. Tape the thermometers to the wall so that the lamps shine directly on them, as shown in the diagram below.
4. Record the thermometer readings in the chart below.
5. Turn on the lamps. Record the thermometer readings at 2-minute intervals for 10 minutes.
6. Calculate and record the change in temperature for each bulb. Compare. Δ = change.

RESULTS:

BULBS	TEMPERATURE (CELSIUS)						ΔT
	0 min	2 min	4 min	6 min	8 min	10 min	
Incandescent							
Compact Fluorescent							

CONCLUSION:



Lightbulb Investigation 2

GOAL: To compare the wattage of an incandescent to a compact fluorescent lightbulb.

MATERIALS: 2 lamps, 1 incandescent lightbulb, 1 compact fluorescent bulb, 1 Kill A Watt Monitor

PREPARATION: Read all of the steps in the procedure.

Write your hypothesis below:

HYPOTHESIS:

PROCEDURE:

1. Place the incandescent bulb in one lamp and the compact fluorescent bulb in the other.
2. Place the lamps on a table.
3. Plug the Kill A Watt Monitor into an outlet and plug the lamp with the incandescent bulb into it.
4. Turn on the lamp. Record the wattage using the Kill A Watt Monitor. Turn off the lamp and unplug it from the monitor.
5. Plug the lamp with the compact fluorescent bulb into the monitor. Turn on the lamp and record the wattage. Turn off the lamp.
6. Compare the wattage measured by the monitor to the stated wattage of the bulbs.

RESULTS:

BULBS	Wattage from Monitor	Stated Wattage
Incandescent		
Compact Fluorescent		

CONCLUSION:

Lightbulb Investigation 3

GOAL: To compare the output of an incandescent to a compact fluorescent lightbulb.

MATERIALS: 2 lamps, 1 incandescent lightbulb, 1 compact fluorescent bulb, 1 light meter

PREPARATION: Read all of the steps in the procedure.

Write your hypothesis below:

HYPOTHESIS:

PROCEDURE:

1. Place the incandescent bulb in one lamp and the compact fluorescent bulb in the other.
2. Place the lamps on a table on identical stacks of books as shown in the diagram below.
3. Plug the lamps into an outlet and turn them on.
4. Use the light meter to measure the light output of the lamps.
6. Compare the output measured by the light meter to the stated output of the bulbs.

RESULTS:

BULBS	Footcandles from Light Meter	Stated Lumen Output
Incandescent		
Compact Fluorescent		

CONCLUSION:

Light Level Investigation

GOAL: To practice using the light meter by investigating the light levels of the classroom, the hallway and outside areas in different conditions.

MATERIALS: 1 light meter

PROCEDURE:

1. Use the light meter to measure the light levels in your classroom with the lights on and off. If you can adjust the amount of light further, measure the light levels for all settings. Record the measurements in the chart below with descriptions of the light settings.
2. Use the light meter to measure the light levels in your classroom, in the hallway outside your classroom and outside at different times of the day. Record the measurements in the chart below with descriptions of the areas and times of day.
3. As you are working on different tasks in the classroom, compare the light level in the room with the recommended light level listed on page 29.

RESULTS:

DESCRIPTION OF AREA AND CONDITIONS	TIME	LIGHT LEVEL

CONCLUSIONS:

The Flicker Checker

The most important difference between incandescent and fluorescent lightbulbs is the process by which they produce light. Incandescent bulbs produce light by passing current through a wire. The wire, often made of tungsten, is a resistor. A resistor is a device that turns electric energy into heat and light energy.

The wire inside an incandescent light bulb is a special type of resistor called a filament. Many incandescent bulbs have clear glass so you can see the filament. In addition to the wire, the bulb contains a gas called argon. The argon gas helps the bulb last longer. If the wire were exposed to air, it would oxidize and the wire would burn out faster. The argon does not react with the metal like air does. The argon also helps the filament be a better resistor—it actually helps it produce more light than air would. Resistors emit more heat than light. In an incandescent light bulb, 90 percent of the energy from the electricity is turned into heat and only 10% of the energy is turned into light.

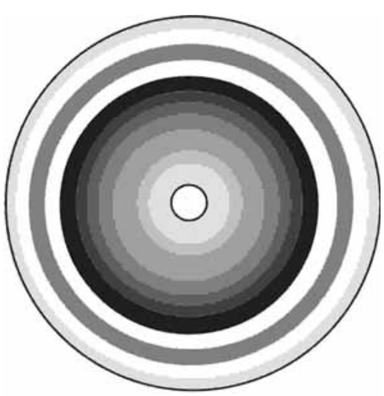
A fluorescent bulb produces light differently. It produces light by passing an electric current through a gas. The electrons in the molecules of gas become excited because of the electrical energy and some escape from the gas molecules. They bounce around and crash into the walls of the tube. The walls of the tubes are painted with a material that gives off light (it fluoresces) when electrons hit it. If you have ever seen the inside of a fluorescent tube, the glass is coated with white powdery material. This powder is what fluoresces (gives off light).

The part of a fluorescent light bulb that sends the current through the gas is called a ballast. There is a part of the ballast at each end of the tube. The ballast is an electromagnet that can produce a large voltage between the two parts. It is this voltage that gives the electrons of the gas molecules the energy inside the tube.

A magnetic ballast has an iron ring wrapped with hundreds of turns of wire. The current from the electrical outlet runs through the wire in the ballast. The wire also is a resistor to some degree, so there is some heat produced. There is also a little heat given off by the gas. A fluorescent bulb with a magnetic ballast converts about 40 percent of the electricity into light and 60 percent into heat.

An electronic ballast has a microchip, like that found in a computer, instead of the coils of wire. This ballast is about 30 percent more efficient in turning electrical energy into light than a magnetic ballast. Some heat is produced in the gas, but not in the ballast itself.

The reason that the Flicker Checker can tell the difference between the magnetic and electronic ballasts is because of the way the current is delivered to the gas. In any outlet in the United States that is powered by an electric company, the electricity is sent as alternating current—it turns on and off 60 times each second. Because the light with the magnetic ballast has wires attached to the outlet, it also turns on and off 60 times per second. The microchip in the electronic ballast can change that frequency. Light bulbs with electronic ballasts are made to turn on and off between 10,000 and 20,000 times each second.



Electronic Ballast

PROCEDURE: Use the Flicker Checker to determine the type of lighting in different areas of your school:

Classroom:

Cafeteria:

Gym:

Hallway:

Office:

Restroom:

Topic Group Questions

Importance of Energy Management in Schools

1. How much energy does your school use and what energy sources produce it?
2. What are the economic benefits to conserving energy at school?
3. What are the environmental benefits to conserving energy at school?
4. What are the health, safety, and educational benefits to conserving energy at school?
5. Does your school have someone in charge of energy management of the building? If so, what are his/her responsibilities?

Building Shell

1. Is the building adequately insulated? Ceiling? Walls? Floor?
2. Do all of the doors seal tightly with no air leakage? Are doors left open when heating or air conditioning systems are operating?
3. Are the windows double–paned? Do they seal tightly with no air leakage? Are windows left open when heating or air conditioning systems are operating?
4. Is there a school policy that regulates when doors and windows can be open? Who is in charge of enforcing the policy?
5. Is landscaping used to help conserve energy around your school building? If not, is it a feasible idea?

HVAC Systems

1. Is water heating integrated into your school's HVAC system? If not, how is water heated?
2. What HVAC systems does your school have? What fuels power your HVAC systems?
3. Is your HVAC system regulated by the central district? If not, how is it regulated?
4. Is the temperature of the building regulated for time of day and usage? Are the temperature settings in line with suggested guidelines?
5. Can individual teachers or administrators override the HVAC controls?

Lighting Systems

1. Is daylighting used to reduce the energy consumption of artificial lighting?
2. Does your school have the most energy-efficient lighting available? If not, what types of lighting?
3. Are lights left on when they are not needed?
4. Are light levels higher that necessary?
5. Does your school use automatic switches, dimmers, and occupancy sensors to reduce energy consumption for lighting?

Appliances and Plugloads

1. Does your school have a policy concerning the use of energy-efficient appliances? Are ENERGY STAR® rated appliances required?
2. Does your school have a policy concerning the management of plugloads?
3. Are machines left on when not in use? If so, which machines?
4. Are staff members allowed to have personal appliances in classrooms and offices? Are these regulated?
5. Are plugloads used with surge protector strips so that phantom loads can be turned off at night?

Topic Group:

Question 1

Essential Details

Question 2

Essential Details

Question 3

Essential Details

Question 4

Essential Details

Question 5

Essential Details

So what? What's important to understand about this?

Building Shell

Importance

HVAC Systems

Energy Management Plan

Lighting

Priorities

Appliances

School Building Survey

General Information

1. When was the school built?
2. What additions have been made? When were they made?
3. What renovations have been made? When were they made?
4. What other facilities use energy on school grounds? Lighted athletic fields? Snack bars? Press box? Storage sheds? Outdoor lighting?
5. What kind of fuels are used to provide energy to the school? For heating, cooling, water heating, lighting, other?
6. What are the total annual energy costs for the school? For electricity? Heating? Water heating? Air conditioning?
7. Are there other energy costs that the school pays for? Transportation?
8. How many hours is the school in use on weekdays? On weekends? In the summer? On holidays?
9. Do other organizations that use the school reimburse the school for energy use?
10. Who is in charge of controlling energy usage in the school? Do others have access to any of the controls? Is there a system in place for regulating and monitoring controls?
11. Who is in charge of maintaining energy-using equipment? Is there a maintenance schedule for all energy-using systems?

Building Envelope

1. What is the building(s) made of? In what condition is it?
2. What is the roofing material? What is the condition of the roof? Are there any leaks in the building when it rains?
3. Is the building designed to make use of passive solar heat and light?
4. In which direction does the building face?
5. How many windows are on each side of the building? Are any windows cracked or broken?
6. What percentage of outside wall space do the windows encompass?
7. How many outside doors are there? Are the outside doors insulated? Are there windows in the doors? Are they double glazed? Are any cracked or broken?
8. Is the building(s) well insulated? Walls? Ceilings?
9. Are interior stairwells open or enclosed?
10. Do windows and doors seal tightly, or do they leak air?
11. Are windows single or double-glazed? Can they be opened? Do the windows have adjustable blinds?
12. Are there awnings or overhangs over windows to shade windows from the overhead direct sun in warm weather, yet allow the slanted rays in winter to enter?
13. Are trees placed around the building to provide shade in warm months?

School Building Survey

Heating/Cooling Systems

1. What kind of heating system is used in the school? What fuel does it use?
2. When was the heating system installed?
3. What is the AFUE (Annual Fuel Utilization Efficiency) of the system?
4. Does the heating system have a programmable thermostat to control temperature? What are the settings?
5. What kind of cooling system is used in the school?
6. When was the cooling system installed?
7. What is the SEER (Seasonal Energy Efficiency Rating) of the cooling system?
8. Does the cooling system have a programmable thermostat to control temperature? What are the settings?
9. Is there an air exchange system when neither the heating nor the cooling system is operating?
10. Are the heating and cooling systems maintained on a regular basis?
11. Are boilers, ducts, and pipes insulated?
12. Does your school make use of passive solar heating?

Lighting

1. What kinds of lighting are used in the school? Outside the school?
2. Are lights and fixtures kept clean?
3. Can lights be controlled with dimmer switches? In which areas or rooms?
4. Does the school make use of skylights and natural lighting?
5. Are there automatic timers for any of the lights?

Water Heating

1. What fuel is used to heat water in the school?
2. Is there more than one water heater? How many?
3. When were they installed?
4. What is/are the EER (Energy Efficiency Rating) of the heaters?
5. Do the water heaters have timers? What are the settings for each heater?
6. At what temperatures are the water heaters set?
7. Are the water heaters and water pipes insulated?
8. Are flow restricters used?
9. Are there leaks in the hot water system?

School Energy Consumption Survey

Even if school buildings are well insulated and have the most modern, efficient energy systems, a significant amount of energy can be wasted if these systems are not controlled and managed wisely. That is where the human element comes in—learning about energy and conservation so that you can use the systems wisely.

Temperature Management

The best heating system in the world cannot operate efficently if outside doors or windows are left open, or if the temperature is not controlled. The same is true for cooling systems. In classrooms and offices, temperature control systems should be set at 68^{o}F during the heating season and 78^{o}F during the cooling season—during the day—and set back at night for optimum efficiency. Programmable thermostats—with access limited to authorized personnel—are recommended. There should also be policies prohibiting the opening of windows and doors during heating and cooling seasons.

If the temperature of offices and classrooms can be individually controlled, there should be policies on permissable temperature ranges in keeping with the recommendations above. Temperature ranges can vary for other rooms in the school—gyms, for example, need not be heated to the same temperature as classrooms when physical activity is scheduled. Auditoriums, hallways, storage rooms, and other little used rooms need not be heated and cooled to the same temperature as occupied rooms.

Rooms and areas that have windows in direct sunlight should be equipped with operational blinds that can help control temperature—closed in cooling months and opened in heating months when sunlight is focused on them. Adjustable vents can also help control temperature.

The relative humidity—the amount of moisture—of the air also affects comfort level. The more moisture, the warmer the air feels. Many furnaces and boilers are equipped with humidifiers to add moisture during heating months when cold air carries little moisture. Many cooling systems have dehumidifiers that remove moisture during cooling months, because hot air is capable of holding more moisture. Optimum comfort for relative humidity is between 35–60 percent during the cooling season, and above 50 percent during the heating season.

Lighting

Lighting—even the most efficient fluorescent system—is not efficient if it is used indiscriminately. In most schools, more light is used than is necessary in most areas and lights are often left on when not in use. Maximum use of natural lighting should be encouraged. Studies have shown that students learn better in natural light than in artificial light. Partial lighting and dimmer switches should be used where available. All lights not necessary for safety should be turned off when rooms are not in use. The same is true for outside lights. Experiment with light levels in your classrooms and determine optimum levels for different tasks, such as reading and taking notes.

Water Heating

Heating water can use a lot of energy, especially if the water is heated all of the time and at too high a temperature. Water heaters should be equipped with timers and the temperature settings should be regulated according to task. For example, washing hands does not require water as hot as washing dishes. Most water heaters are set much higher than necessary for the task. The water in classrooms and lavatories need not be set higher than 90^{o}F. In shower rooms, it need not be set higher than 100^{o}F. Only kitchens may require hotter temperatures for safety purposes. In science labs, it is more efficient to heat water when it is needed than to maintain tap water at high temperatures.

Electrical Appliances

Many computers, VCRs and other electrical appliances draw electricity even when they are turned off. These appliances should be plugged in to surge protectors so that all of the power can be turned off when they are not in use, or at the end of the day. These surge protectors can also protect equipment against sudden power surges that can damage their electrical systems.

Many copiers and computers have a long warm–up time that makes it difficult to turn them off and on as they are needed. In many schools, however, they are left on 24 hours a day. Turning TVs and VCRs off when not in use, and computers and copiers off at the end of the day, can save a significant amount of energy.

Recording Form 1

DATE ___________ **TIME** ____________ **OUTDOOR TEMPERATURE** ________________

OUTDOOR RELATIVE HUMIDITY __________________ **WEATHER** ____________________

IS A HEATING OR COOLING SYSTEM OPERATING? _________________________________

Classroom # __________________________

Number of Windows	______________		
Direction Windows Face	______________		
Indoor Temperature	______________		
Relative Humidity	______________		
Light Meter Reading	______________		
Hot Water Temperature	______________		
Is there a thermostat?		Yes	No
Are there adjustable vents?		Yes	No
Are there adjustable lights?		Yes	No
Are lights on?	No	Some	All
Are windows open?	No	Some	All
Are blinds closed?	No	Some	All
Are faucets dripping?	No	Some	All

Lamps: _____T-8 _____T-12

Ballasts: _____Electronic _____Magnetic

List electrical devices that are turned on. Are they in use?

Other Comments:

Classroom # __________________________

Number of Windows	______________		
Direction Windows Face	______________		
Indoor Temperature	______________		
Relative Humidity	______________		
Light Meter Reading	______________		
Hot Water Temperature	______________		
Is there a thermostat?		Yes	No
Are there adjustable vents?		Yes	No
Are there adjustable lights?		Yes	No
Are lights on?	No	Some	All
Are windows open?	No	Some	All
Are blinds closed?	No	Some	All
Are faucets dripping?	No	Some	All

Lamps: _____T-8 _____T-12

Ballasts: _____Electronic _____Magnetic

List electrical devices that are turned on. Are they in use?

Other Comments:

Recording Form 2

DATE:

TIME:

Common Area # ______________________

Number of Windows ____________

Direction Windows Face ____________

Indoor Temperature ____________

Relative Humidity ____________

Light Meter Reading ____________

Is there a thermostat? Yes No

Are there adjustable vents? Yes No

Are there adjustable lights? Yes No

Are lights on? No Some All

Are windows open? No Some All

Are blinds closed? No Some All

Are doors tightly closed? No Some All

Lamps: _____T-8 _____T-12

Ballasts: _____Electronic _____Magnetic

List electrical devices that are turned on. Are they in use?

Other Comments:

DATE:

TIME:

Non–Class Room # ____________________

Number of Windows ____________

Direction Windows Face ____________

Indoor Temperature ____________

Relative Humidity ____________

Light Meter Reading ____________

Is there a thermostat? Yes No

Are there adjustable vents? Yes No

Are there adjustable lights? Yes No

Are lights on? No Some All

Are windows open? No Some All

Are blinds closed? No Some All

Are doors tightly closed? No Some All

Lamps: _____T-8 _____T-12

Ballasts: _____Electronic _____Magnetic

List electrical devices that are turned on. Are they in use?

Other Comments:

Energy Management Plan

A comprehensive energy management plan for a school should have several components:

Renovations to the building and energy systems to make them operate more efficiently.

Control and management of the energy systems so that they are used only when necessary and at prescribed settings.

Modification of behaviors of all of the consumers in the school—administrators, students, teachers, and janitors, as well as community members who use the facility.

Building & Energy System Renovations

There will be few building renovations that you as students can accomplish yourselves, except for perhaps minor repairs such as replacing broken windows, caulking, weatherstripping, and planting shade trees. Depending on how comprehensive the plan will be, you can research major renovations and new systems with their costs and payback periods, or simply prioritize the school's needs and make recommendations for improvements.

Your energy management plan should include improvements to the building envelope, as well as improvements to the heating, cooling, lighting, and hot water heating systems. The building survey that you did will point out the major deficiencies. You need to prioritize those problems and decide what changes can realistically be made in the short term and what long-term goals the school should have for increasing efficiency.

If the heating system is 25 years old, it might make sense to recommend replacing it with a new, high-efficiency system, showing how quickly the cost of the system will be paid back with energy savings. If, on the other hand, the system is only ten years old, replacing the system might be a long-term goal, even if it is not as efficient as new systems.

System Control & Management

You can have a significant impact on energy conservation by controlling and managing the energy systems in your school—determining optimum temperature settings, maintenance schedules, and policies for control of the energy systems. Be sure you consider outside areas and common areas, as well as classrooms and offices.

Installing inexpensive timers and programmable thermostats to control systems and reducing the number of people with access to controls can make a major difference. Installing blinds on windows in the direct sun and installing vents that can be opened and closed are additional ideas. Can dimmer switches be used with the light system in your school? Some fluorescent systems can be dimmed, others can't.

Look at the results of the **Building Survey and the Energy Consumption Survey** to show you where the major deficiencies are, then prioritize the problems. If every room in the school has a window air conditioner, it is much harder to control usage than if there is a central system.

Behavior Modification—Teaching Others

Changing the way people use energy can result in significant energy savings. Shut off the lights every time you leave a room. Don't leave hot water faucets running or dripping—turn them off completely. Keep windows and doors closed when the heating and cooling systems are on. Use natural lighting. Turn computers on only on days when you need to use them. The list goes on and on.

You can make a big difference in school energy consumption by developing a campaign to educate school consumers about conservation practices. Develop a plan for teaching everyone what you have learned from the **Building** and **Energy Consumption Surveys**, and showing them what they can do to save energy. Show them how saving energy helps protect the environment. Show them how saving energy saves money.

How will you get the message out? An article in the school newspaper? A special assembly? Posters in the halls? Announcements over the PA system? How will the program be reinforced throughout the year? A good education program must be ongoing or consumers will fall back into old energy-wasting habits.

A program to return the money saved to the school for educational programs can be an incentive for encouraging energy-saving behaviors. What other incentives might be effective?

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